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A FEDERAL PLAN FOR NATURAL DISASTER WARNING AND PREPAREDNESS

National Oceanic and Atmospheric Administration

Prepared for:

Environmental Protection Agency
National Science Foundation
Office of Telecommunications Policy

June 1973

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A FEDERAL PLAN
FOR
NATURAL DISASTER
WARNING AND PREPAREDNESS

Federal Committee for Meteorological Services and Supporting Research

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16. ABSTRACT

This Federal Plan is described in this report and is addressed to programs that relate to natural disasters caused by geophysical phenomena. This plan was conconceived as a joint effort of the agencies involved to present a coordinated response to the needs that are known to exist in our programs to detect, predict, warn and prepare for natural disasters. The single goal is to reduce loss of life and property from such disasters by presenting a plan for concerted actions that are technologically possible and focusing attention on areas where additional research affords the most promise for improvements in the warning system and community preparedness. The plan is divided into 5 sections. The first two sections establish the background for a Plan and identify the authority and source of needs to which the Plan is addressed. Section 3 discusses the functions of environmental monitoring, warning preparation and warning dissemination. Section 4 discusses community preparedness and Section 5 is a detailed description of needs versus programmed actions, costs and benefits. The FY 74 programs shown are contained in the President's budget. (Author extracted)

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Foreword

Extreme atmospheric forces and violent movements of the earth's crust can cause disastrous phenomena which pose a threat to man's life, his property and his daily pursuits. Although natural disasters cannot now be controlled, much can be done to mitigate their impact before they occur and when they are occurring. Many Federal departments have extensive programs to carry out their assigned responsibilities in the broad fields of disaster warning and community preparedness. This Federal Plan is addressed to programs that relate to natural disasters caused by geophysical phenomena.

This Plan was conceived as a joint effort of the agencies involved to present a coordinated response to the needs that are known to exist in our programs to detect, predict, warn and prepare for natural disasters. The single goal is to reduce loss of life and property from such disasters by presenting a plan for concerted actions that are technologically possible and focusing attention on areas where additional research affords the most promise for improvements in the warning system and community preparedness.

Agencies which assisted in the preparation of this Plan are Departments of Agriculture, Commerce, Defense, Interior, and Transportation, the National Aeronautics and Space Administration, the National Communications System, the National Science Foundation, the Environmental Protection Agency and the Office of Telecommunications Policy. In addition, the Office of Emergency Preparedness and the Federal Communications Commission participated as observers.

During the late stages of the preparation of this Plan, action was being taken which would clarify responsibilities and roles of several agencies. Since the impending changes were not completed before the Plan was finished, they could not be incorporated in the Plan. The functions of the Office of Emergency Preparedness in disaster assistance and preparedness planning, and the functions of the National Oceanic and Atmospheric Administration, the National Science Foundation and the Department of Interior (U.S. Geological Survey) in certain earthquake-related programs are those affected. The major impact of these changes will be a new role for the Department of Housing and Urban Development in preparedness planning, and the assumption of strong motion engineering functions and earthquake predictions, hazards reduction and seismic observing functions of the National Oceanic and Atmospheric Administration by the National Science Foundation and the Department of Interior, respectively.

The Plan is divided into five sections. The first two sections establish the background for a Plan and identify the authority and source of needs to which the Plan is addressed. Section 3 discusses the functions of environmental monitoring, warning preparation and warning dissemination. Section 4 discusses community preparedness and Section 5 is a detailed description of needs versus programmed actions, costs and benefits. The FY 74 programs shown are contained in the President's budget. Follow-on programs for FY 75 and beyond are for planning purposes only. The pace and extent to which these follow-on plans will be implemented will depend on budgetary decisions which will have to be made in the context of the total national fiscal and program needs.

ROBERT M. WHITE
Chairman,
Federal Committee for Meteorological
Services and Supporting Research

Executive Summary

The "Report to the Congress on Disaster Preparedness" by the Office of Emergency Preparedness, January 1972, and the report, "The Agnes Floods" by the National Advisory Committee on Oceans and Atmosphere, November 22, 1972, together with other disaster surveys, have identified many unmet needs in the existing natural disaster warning system and community preparedness. This Plan addresses those unmet needs within the concept of a balanced program which recognizes the close interaction between the warning system and community preparedness. The unmet needs are many, however, and together with the very nature and complexity of the phenomena with which we are dealing lead to program planning that extends over several years in order to achieve improvements necessary to meet these needs. Assuming a continuation of current priorities and present rate of funding, this Plan describes the long-range efforts of all Federal agencies with responsibilities to warn about, prepare for, and mitigate the impact of potential geophysical natural disasters, including those caused by hurricanes, tornadoes, floods and earthquakes. In this Executive Summary of the Plan, features of the warning system and community preparedness that are common to several of these phenomena are discussed first, followed by sections dealing with the specific phenomena.

WARNING SYSTEM

The warning system is composed of the basic elements of monitoring, warning preparation, and warning dissemination. The effectiveness of the warning system to achieve its goal of the appropriate response by the general public to minimize loss of life and property is equally dependent on each of these three vital elements.

MONITORING

Monitoring must fulfill the needs for reliable detection and tracking of specific hazardous phenomena and, at the same time, it must provide data to support forecasts and assessments of these phenomena as well as geophysical changes. Many of the monitoring elements that are now operational have a multi-purpose capability that is fundamental to specific disaster warning functions as well as day-to-day prediction and information services. These elements include polar-orbiting satellites, radar, aerial reconnaissance, upper air soundings, and numerous hydrologic and surface weather stations. More specialized observational facilities include severe storm spotter networks, flash flood alarms, and coastal stations. Additional highly specialized systems monitor earthquakes, tsunamis, frosts and freezes, extreme fire weather conditions, droughts, landslides and volcanoes.

Planned improvements include the use of one of the more outstanding technological developments in recent years, the Geostationary Operational Environmental Satellite (GOES) that will provide near continuous storm surveillance and the automated relay of data from remote sites. The two-GOES system is expected to be operational beginning in late FY 1974. Other technological developments, for example, remote sensing of the atmosphere by acoustic sounding and optical lidar techniques, will continue to emphasize those areas showing the greatest promise for improved monitoring capabilities.

Additional radars are planned to improve monitoring of potentially severe thunderstorms, some tornadoes, and areas of heavy rainfall. Radars perform vital functions also in approximating precipitation rates and in tracking hurricanes as they approach the coast. The basic concept of NOAA is that each office having county warning responsibility should have direct access to radar information. Stations not equipped with radar can be furnished support by remoting data from nearby primary radars. The goal is to complete the planned radar coverage by implementation of 71 new radars by the end of FY 1978 beginning with 20 in FY 1974. Contributing programs including digitizing and automating of radar data and remoting of data will extend to FY 1978 or beyond.

The large basic networks of surface and upper air observations that support the forecast and warning system are essentially complete. Forced relocations of stations, depreciation of equipment and changes in supporting agencies require continuing annual expenditures to sustain the system's effectiveness. Additional automatic weather stations will be used to provide continuing observations from Coast Guard facilities that are being converted from manual to automated operations. These programs will provide the basis for improved forecasts of hurricanes and storm surges along coastal areas. Fifty-two additional automatic weather stations will be procured in FY 1974 to provide observations from remote locations and from other points where cooperating agencies discontinue observations. Also, additional automated tide and wave gages are required to provide detailed data needed along the coasts when hurricanes are approaching.

River District Offices of the National Weather Service actively cooperate with field offices of the Corps of Engineers, Department of Agriculture and Department of Interior to maintain the hydrologic network. The present hydrologic networks do not provide adequate coverage in many flood prone areas and are too dependent on manual operation. Expansion of the observing network to 10,000 stations, approximately twice its present size, within the next few years is necessary to provide many new stations in flood prone, mountainous areas. During the same period, fifty percent of the river and rainfall gages will be automated with a remote readout capability in the River District Offices and River Forecast Centers using direct distance dial telephone or the GOES satellite.

Improved aerial reconnaissance capability is planned through replacement and modernization of existing aircraft to collect data on tropical disturbances and severe winter storms, and also to support weather modification experiments and operations. Reconnaissance aircraft, primarily of the Department of Defense, penetrate tropical disturbances to provide data essential to NOAA's National Hurricane Center's forecast and warning program. Reconnaissance is also flown on severe winter storms along the East Coast of the United States in support of forecasts and warnings of these phenomena. NOAA aircraft are used primarily for weather modification experiments and to collect data in support of research requirements. Planned system improvements include modernization of the NOAA aircraft fleet by phased replacement of obsolete aircraft and development and use of improved instrumentation and data relay systems in both Air Weather Service and NOAA reconnaissance aircraft.

WARNING PREPARATION

Warning preparation must include the capability for processing and analyzing large amounts of data for the forecasting of small-scale hazardous phenomena as well as the large-scale systems in which the hazards are embedded. The concept within which forecasts and warnings are prepared and issued is essentially the same for most types of atmospheric natural disasters. Guidance centers provide basic analyses and forecasts which are distributed by facsimile and teletypewriter networks to offices with special warning responsibilities (e.g. Hurricane Centers and Hurricane Warning Offices) and to River Forecast Centers, Weather Service Forecast Offices and Weather Service Offices where area and local warnings are issued. A more powerful computer is planned in FY 1974 for use in the National Meteorological Center and the National Environmental Satellite Service. This increased capability will permit the development and test of improved numerical models and techniques for integration and real-time use of satellite data in numerical forecasting. The more powerful computer will also permit the use of models with a higher resolution, thereby offering the best opportunity for improved forecasts of small-scale severe local storms and heavy rains.

Early improvements are planned in the management system for better coordination of warnings. Specifically, a Regional Warning Coordination Center (RWCC) is being established in each of the four National Weather Service regions in the contiguous United States.

Effective improvements in the long term may be achieved by automating the data handling, display, communications, and dissemination functions in a manner which will also conserve manpower. The Automation of Field Operations and Services (AFOS) System, under prototype development by NOAA could greatly enhance the capability of NOAA to respond to weather emergencies as well as to streamline and modernize the overall field operation. At the same time, it may offer the potential, once fully implemented, for significant manpower savings. The AFOS system proposes that each Weather Service Forecast Office would have a mini-computer with a capability for electronic storage and automated screening and call-up of all data now processed by hand. Interconnecting high-speed communication circuits would allow rapid interchange of data and coordination of warnings. Beginning with the prototype development of selected components of AFOS in FY 1974, the planned completion of the system if implemented at 227 locations would require phasing through FY 1979.

WARNING DISSEMINATION

Warning dissemination methods must be designed to provide warnings of all types of disasters with minimum delay to all who need the information to allow adequate lead time for making decisions and taking protective actions. Recent disaster survey reports have identified improvements in warning dissemination as among the most urgent needs. Dissemination systems currently in use also serve as a means to disseminate general weather information and forecasts. None of these systems is complete in itself. They are used to supplement one another so as to make warnings available to the greatest number of people who require them. Communication systems used in the dissemination of warnings include office to office teletypewriter circuits, special circuits to serve the mass news media and government officials, and public contact systems.

The office to office systems include the Radar Report and Warning Coordination (RAWARC) teletypewriter network and the National Warning System (NAWAS) telephone party-line network. The RAWARC network is useful for relay of warning information between offices for coordination purposes and especially for further relay by receiving stations to points that are not directly accessible via other disseminating systems from a given warning office. NAWAS is also used for exchanging information between warning offices.

The special circuits used for dissemination of weather warnings and forecasts to the mass news media and government officials are the NOAA Weather Wire Service, the National Warning System (NAWAS) and local public service teletypewriter circuits. The further dissemination by the news media of forecasts and warning information to the public is a valuable local service. The NAWAS, in addition to reaching many government officials, is especially useful for obtaining feedback from volunteer observer spotter networks and from police and other local authorities in areas warned.

Systems used by warning offices for direct public contact include, VHF/FM continuous weather radio transmissions of taped messages, multiple access recorded telephone announcement systems and local civil defense siren systems. The VHF/FM continuous radio transmissions are especially useful to persons who are at remote locations without access to telephones such as camp sites or on boats. It also serves those who need to update weather information frequently without delay occasioned by over-loaded telephone circuits. An added feature of this system is the capability for turning on radios to alert users to be ready for important weather messages. Multiple-access recorded telephone announcement systems also provide taped weather messages on demand to millions of users. The local civil defense siren system designed for use with NAWAS for dissemination of attack warnings is available for local public contact use in some communities for alerting individuals who may not have access to radio or telephone.

Another prototype system, the Decision Information Distribution System (DIDS), is being investigated by DCPA. If implemented it would provide a capability for simultaneous issuance of attack warnings throughout the United States and for use in distributing warnings of natural disasters. The prototype deployment of the first of ten proposed low frequency radio distribution facilities will be at Edgewood, Maryland by mid-1973. Implementation plans will depend upon evaluation of the prototype project.

The potential advantages of the application of satellite technology to disaster warning have been investigated in preliminary studies. Therefore, NOAA in conjunction with NASA has been studying the feasibility of a Disaster Warning Satellite System for both the dissemination of natural disaster warnings and the collection of data and feedback information before and during natural disasters.

A substantial effort is necessary to improve dissemination of forecast and warning information through FY 1978. The RAWARC network is scheduled for completion in FY 1974 and the NWWS will be about 75% complete in FY 1974 with proposed completion in FY 1978. VHF/FM stations and multiple-access telephone recorded announcement systems will be added to complete about 45% of the planned systems in FY 1974 and are proposed to complete 70% in FY 78. A recently initiated service to CATV systems should reach about one-third of 30 planned CATV systems by FY 1978 given present priorities and rate of funding. Dissemination requirements for services to CATV systems, additional NAWAS drops, and additions to telephone announcement systems will continue to evolve as urban areas develop and demand grows.

COMMUNITY PREPAREDNESS

Community preparedness is the final link in the chain of Federal programs to mitigate the impact of natural disasters. It consists of risk assessments and planned actions based upon those assessments which are designed to stimulate specific and uniform public responses. Planning is the true measure of preparedness, and it is most important at the community level where public response to warnings translates directly into lives and property saved.

The DCPA is continuing to give high priority to its On-Site Assistance efforts to help local governments improve their emergency planning to cope with natural disasters. This major program has been expanded rapidly during FY 1973 by using the full resources of the DCPA Regional Offices. Action plans have been completed for 164 communities and 452 more are under development with many more planned to be initiated in FY 1974. Progress in the continued development of such action plans will depend upon the interest of local communities. Other Federal agencies, particularly NOAA, work closely with DCPA to present a fully coordinated Federal assistance effort. Community preparedness specialists are being assigned to 14 key field offices of the National Weather Service to work with local officials and organizations in FY 1974. Assignment of specialists to an additional 38 offices through FY 1978 would complete this program. The efforts of these specialists will also be directed at public education on the warning system, personnel safety rules and protective shelters through presentations to various civic groups, news media broadcasts and community preparedness planning meetings.

NATURAL DISASTERS

The following discussions are directed toward more specific aspects of the warning system and community preparedness for each type of natural disaster.

HURRICANES AND STORM SURGES

The overall effectiveness of the hurricane warning service is in large part dependent on a family of monitoring systems -- satellite, aerial reconnaissance, radar and coastal stations. Satellites provide a capability to detect tropical cyclones in their earliest stages of formation and to monitor their general development and movement. The two-GOES system, expected to be operational in FY 1974, will provide near-continuous cloud imagery over a broad area detecting hurricanes while they are far at sea. Polar orbiting satellites (ITOS) supplement the GOES with sounding data. Equipment and personnel for use of GOES and ITOS data will be provided to all National Weather Service key centers and forecast offices. The completion objectives are 40% in FY 1974 and 100% in FY 1978.

Aerial reconnaissance provides more accurate fixes on storm positions and detailed information on pressure, temperature and wind velocity. These essential data are vitally important as storms approach the coast. Three of the four NOAA aircraft are obsolete and are being phased out. One new four-engine replacement aircraft will be procured in FY 1974. Two airborne automated data acquisition systems (Airborne Weather Reconnaissance System--AWRS) will be procured in FY 1974 for use aboard the new aircraft and the remaining NOAA C-130 aircraft. Additional AWRS are planned to be installed on Air Force aircraft by the end of FY 1976 which will augment their use in hurricane reconnaissance and research.

Radar stations along the coast continually monitor position and movement of a hurricane during the critical period of landfall. The implementation of long-range network radars along the Gulf and Atlantic coasts is complete. Two local-use radars will be installed along the Gulf coast in FY 1974, to replace obsolete radars at Corpus Christi, Texas, and Mobile, Alabama.

Special networks that provide data needed when tropical cyclones approach the coast are the Cooperative Hurricane Reporting Network (CHURN) and the Tide Height Reporting Network. Additional automated tide and wave gages are planned. Coverage objectives are about 15% in FY 1974 and 65% in FY 1978.

Continuing research and greater computer capability are planned to develop and test improved statistical and other numerical techniques for more exact predictions of a hurricane's course, landfall, and intensity. Research in hurricane modification also offers encouragement for reduction in losses. Project STORMFURY, which seeks to explore the structure and dynamics of hurricanes and the potential to modify their destructive power, will be accelerated with a field experiment in the Pacific in FY 1976, when planned improvements to the aerial support capability will be completed.

The assessment of hurricane and storm surge risks through mapping programs on the frequency and intensity of atmospheric disasters will be continued. Also, the hurricane evacuation mapping program is planned to be accelerated with 4 areas completed by FY 1974 and an objective of 22 areas or 55% by FY 1978. This program will cover densely populated areas of the Gulf and Atlantic coasts.

TORNADOES AND SEVERE LOCAL STORMS

Tornadoes are difficult to detect and predict because of their relative small size and short life span. NOAA's National Weather Service uses a system of watches and warnings to alert the public -- watches for areas where tornadoes are expected to develop -- warnings when they have been visually sighted or strongly indicated by radar. Satellite data, particularly from geostationary satellites, will be more fully exploited in tornado and severe thunderstorm detection and forecasting. Although many advances have been made in severe storm prediction techniques, much research is needed on the dynamics and modeling of convective storms as a basis for further improvement in forecasting techniques.

The planned weather radar coverage includes a phased addition of five long-range radars and 66 local use radars. Either local use radars or radar remotes are planned to serve each weather office having warning responsibility. Two long-range radars and 18 local use radars are included in the FY 1974 program. The objective is to complete the procurement and installation and begin operation of the 71 radars by the end of FY 1978. Approximately 55% of the radar remote program is now in operation. The program to complete the system of 60 transmitters and 100 receivers will extend to FY 1978 or beyond. The radar network is supplemented by Air Force and Navy installations in the conterminous U.S. and Alaska, and by FAA radar in the Rocky Mountain and Pacific Coast areas. Expansion of the program for joint use of Federal Aviation Administration radars is planned to include Denver, Colorado, in FY 1974 and Anchorage, Alaska, in FY 1975. Also, a system for digitizing and automating radar data is being investigated for use with all long-range radars and is proposed for implementation. Five will be in use by the end of FY 1974. Fifty-one more will be necessary to complete installations through FY 1978. Investigations of Doppler radar, which have shown great promise for the detection of tornadoes, will be pursued in FY 1974.

To supplement the radar network in the detection of severe storms and tornadoes, strong dependence is placed on cooperative spotter reports from police and trained citizens. Local Weather Service Offices recruit and train volunteer severe local storm spotters in cooperation with city, county and state offices to form networks of observing points. These networks are alerted on the basis of severe weather watch bulletins and observed radar echoes to watch for and report severe storms or tornadoes which they observe. The continued use and expansion of cooperative spotter networks are planned.

Also, the near-continuous observations from the two-GOES system will be fully utilized in the forecasting of severe local storms and tornadoes. A special satellite unit established this year at NOAA's National Severe Storm Forecast Center provides data from the geostationary Applications Technology Satellite (ATS) to support the severe thunderstorm and tornado watches issued for the United States. The staff and equipment of the satellite unit will be increased more than three-fold in FY 1974 to better utilize the eight-fold increase in information that the two-GOES system will provide over ATS.

The timeliness of watches and warnings will be improved with the implementation of automation programs and through the expansion of multiple-use dissemination systems.

Weather modification research projects and experiments will be conducted in FY 1974 to develop modification methods for severe thunderstorms. Research will be continued by NOAA and NSF to develop a better understanding of severe thunderstorms and tornadoes as a basis for improved detection and forecasting techniques. In addition, research will be pursued on the identification of tornadoes by electromagnetic emissions, which has shown great promise.

RIVER AND FLASH FLOODS

The present river and flash flood monitoring system is vulnerable to heavy rain and flood and does not provide adequate coverage in remote areas. To minimize reliance on manual operations during emergency situations, NOAA plans to automate a number of river and rainfall stations each year and to increase the number of stations until the network is complete with about 10,300 stations of which approximately one-half are automated. At the present rate of funding, about 3,000 stations will remain to be added after FY 1978. In FY 1973, 175 river and rainfall stations are being automated and in FY 1974 an additional 175 are planned with data collection by direct-dial telephone or through the Geostationary Operational Environmental Satellite system (GOES) to complete about 20% of the automation program. The implementation goal is 2,300 stations by FY 1978 which will complete 40% of the automation program. Station automation and satellite data collection will decrease the vulnerability of the network to extreme conditions and make data available on-call for near real-time use in critical situations.

The River and Flood Forecast Service will be extended to all states by the end of FY 1975 and to cope with the critical stresses on the warning system that develop during emergency situations, the capabilities of River Forecast Centers will be improved. Given present levels of funding and priorities these improvements are planned to be completed by FY 1978, including personnel augmentation of seven River Forecast Centers to provide weekend and nighttime operations and improved computer capabilities. Augmentation of the staffs of two centers is planned in FY 1974 and others in following years. With FY 1974 funding, all River Forecast Centers will have some computer capability with plans to use more sophisticated hydrologic models as they are developed.

Plans to satisfy the urgent need for an improved flash flood program must be developed to include improved monitoring in remote locations, capability for rapid alerting of local officials, and improved community preparedness and public response. Many of these needed improvements will be achieved by relatively long-term programs that provide full coordination and interaction between each phased element and also allow rational trade-offs between cost effectiveness and urgency of implementation.

Delays in acquisition of information about the occurrence of very large amounts of rainfall in relatively short periods of time limit the effectiveness of the present warning system. Completion and modernization of the radar network will contribute to improved rainfall monitoring. Implementation of the digitizing system will provide measurements of rainfall intensities from remote areas and allow more rapid transmission and assimilation of the data for analysis and forecasting of potential floods. This will improve both the accuracy and timeliness of flood and flash flood warnings.

Some of the most urgent needs of the flash flood program can be met by the relatively new and effective automatic flash flood alarm devices. The alarms are low in cost and easily installed, but a thorough hydrologic survey is required to determine where they will be most effective. Assistance in the development of community preparedness plans for appropriate public response is also essential. Six automatic alarms are now in operation with 4 more being installed in FY 1973. Procurement of 20 is planned in FY 1973 and 25 more in FY 1974 to initiate the program. By the end of FY 1978 the goal is to have installed 250 alarm systems and to assist in the development of more self-help prediction systems and community preparedness plans in close coordination with the DCPA. This is about 20% of the estimated need for 1500 flash flood alarm systems.

Planned expansion of the multiple-use dissemination systems will improve the availability and timeliness of river and flash flood warnings. These systems include additional drops on NAWAS, expansion of the NWWS, addition of VHF/FM stations and multiple-access recorded announcement telephone systems. Also the alerting capabilities inherent in the new flash flood alarm devices will contribute to dissemination capabilities.

Assessment of flood risks will be aided by the river flood plain mapping program. This program will be expanded as necessary to satisfy requirements expressed by user agencies.

EARTHQUAKES

Monitoring of the solid earth will be improved by plans to expand networks to gather additional seismic and strong motion data in regions of important earthquake activity. These programs will provide data to support faster and more accurate location of epicenters and to support major research programs and investigation of methods for earthquake prediction and control that are planned by the National Science Foundation and the Department of Interior. The goal is to complete these networks by FY 1978.

Technology has not yet developed to the point where individual damaging earthquakes can be forecast. However, there is a possibility that the magnitude of earthquakes can be controlled. Expansion of monitoring networks of instrumentation in the earthquake hazards reduction program of the Department of Interior is planned in FY 1974 in areas of frequent seismic activity. It is expected that FY 1974 funding would meet most of the current planned network requirements. Efforts will be continued to improve the useability of risk assessment information designed to support local planning officials, engineers and scientists. Data from these networks will also be used to support research on earthquake mechanisms, prediction techniques, and possible control procedures. In addition, continuing extensive research programs are planned by the National Science Foundation in earthquake engineering design and to develop applications and information requirements of both industry and research interests.

The need for accurate and timely tsunami warnings presents challenging problems. Accurate prediction of tsunami wave height at any given point around the Pacific is not now feasible. The timeliness of tsunami information and warnings will be improved by automating and equipping seismic and the tide stations for relay of data through the GOES system to the National Tsunami Warning Center in Hawaii. This program is planned for completion during the period FY 1975 through FY 1979.

OTHER NATURAL DISASTERS

Additional types of natural disasters addressed in the OEP Report include extreme fire weather, droughts, frosts and freezes, volcanoes, landslides and avalanches.

In response to the need for improved and expanded fire weather services for all fire control agencies, NOAA has led the development of a "Federal Plan for a National Fire Weather Service". This Plan is now about 60% implemented but applied research aspects directed toward improving fire weather forecasts have not been implemented and need attention. Completion of phased implementation is the objective during the FY 1975-1977 period. As an integral part of its fire protection program, the Department of Agriculture, Forest Service is developing a national fire-danger rating system. The implementation of this system will be completed by the end of calendar year 1974.

Continuing drought assessment programs are operated by NOAA and by the Geological Survey of the Department of the Interior. In 1974 NOAA will accelerate its tropical cumulus modification experiment to assist prediction of precipitation potential of convective clouds. The Department of Interior has a continuing research program on cloud seeding for drought relief. Research will be continued to improve techniques for cloud seeding to relieve droughts.

NOAA provides agricultural frost and freeze warning services that are keyed to the "Federal Plan for a National Agricultural Weather Service." Implementation of this plan is now about 35% complete. Phased annual increments are proposed during the period FY 1975-FY 1977 to complete this service for all agricultural states in the contiguous United States.

The staff of the Geological Survey of the Department of Interior at the Hawaiian Volcano Observatory monitors the active volcanoes Kilauea and Mauna Loa. Most volcanoes in the contiguous United States, which are in the Pacific Northwest, are inactive and thus pose only a relatively latent threat. Instrumentation to monitor inactive volcanoes in the Pacific Northwest will be installed in FY 1973 and infrared satellite data will be used to monitor volcanic activity. These programs will provide improved risk assessments.

The Geological Survey has a continuing risk mapping program of landslide studies in areas prone to slides. Studies are also directed toward developing a basic understanding of the conditions under which landslides occur.

The Forest Service of the Department of Agriculture now evaluates snow avalanche hazard at specific heavy use areas in the western United States. Under extreme conditions, general warnings of possible avalanche activity are issued through the National Weather Service dissemination facilities. National Forests and universities cooperate in this warning program primarily in the States of Colorado and Washington.

PROGRAMS BY AGENCY

(FY 1973 Total Programs - FY 1974 Increases)

	WARNING SYSTEM						COMMUNITY PREPAREDNESS				RESEARCH[2]	
	Monitoring		Warning Preparation		Warning Dissemination		Assessments		Planning			
	1973	1974	1973	1974	1973	1974	1973	1974	1973	1974	1973	1974
COB							10,500	0				
DCPA					7,799	675	10,333	746	17,880	1,864	3,500	-500
DOA	600	100									850	50
DOI	260	300		1,000	0	100	3,817	850			6,600	-2,750
NOAA	28,542	10,442	26,057	3,062	12,945	1,275	100	0	145	520	12,400	10,663
NSF											20,800	3,760
Total	29,402	10,842	26,057	4,062	20,744	2,050	24,750	1,596	18,025	2,384	44,150	11,223

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[1] DCPA funds of $41,885 for FY 1973 and +2,728 increase for FY 1974 are not included in the table. These funds are for program management which includes funds for Federal personnel and administration and funds allocated by DCPA to the state and local governments for the same purpose.

[2] Research funds support all functional areas, including weather modification and earthquake control efforts.

[3] The satellite portion of NOAA monitoring includes prorated costs of GOES which supports environmental warning services. It does not include costs of ITOS, which supplements GOES but primarily supports basic environmental services.

Part I - Introduction

The United States operates the most extensive natural disaster warning and preparedness system in the world. However, each year in the United States, natural disasters exact an enormous toll in lives, economic losses and human suffering. The losses result, in part, from existing needs in our warning and preparedness programs which have been identified and can be met.

In 1972 and early 1973, the following events focused renewed attention on the need for Federal actions to cope with natural disaster problems.

- The President's message to Congress on applications of science and technology specifically mentioned the need for "working to reduce loss of life and property from natural disasters".
- The President's message to Congress on the FY 1974 budget mentioned the need for increased outlays to improve monitoring, prediction and warning programs, including a new meteorological satellite system and the global atmospheric research program.
- The OEP Report to the Congress on Disaster Preparedness pointed to the need for improving disaster warning and preparedness planning at all levels.
- The report on the Agnes Floods by the National Advisory Committee on Oceans and Atmosphere directed special attention to the need for improving warning dissemination systems along with storm prediction and flood data-gathering.

Later in the year, natural disasters themselves directed even greater attention on the need for action. In retrospect, 1972 was the year of natural disasters. The President declared 48 major disaster areas. Flash floods in South Dakota caused 235 deaths and almost total destruction over a small area. Hurricane Agnes caused severe and extensive flooding and caused the loss of 122 lives and $3.5 billion in property destruction, the greatest economic loss in the Nation's history due to a natural disaster. Post-disaster surveys which were conducted in both cases identified existing unmet needs. In particular, the Report on the Agnes Floods by the National Advisory Committee on the Oceans and Atmosphere (NACOA) identified needed improvements in the monitoring, warning preparation and warning dissemination system and in community preparedness planning.

PURPOSE

This Plan presents the Federal action programs and plans that will meet the needs of disaster warning and community preparedness activities to provide maximum protection for life, property and daily pursuits. All Federal activities specifically concerned with disaster warnings and community preparedness are described, coordinated and planned in the context of needs identified in the findings of the OEP Report to Congress on Disaster Preparedness, the NACOA Report on the Agnes Floods and the post-disaster surveys conducted by individual agencies.

SCOPE

Successful mitigation of the impact of natural disasters depends on accurate and timely warnings complemented by effective community preparedness plans and programs. Natural disaster warnings and community preparedness go hand in hand. This Plan addresses in detail the major elements of the warning system; namely environmental monitoring, warning preparation and warning dissemination, as well as the broad aspects of community preparedness. Numerous Federal agencies have specific functional responsibilities directly related to one or more aspects of meeting the needs of the general public for warnings of, and preparedness for, impending disasters. The roles of these Federal agencies are outlined. Natural disasters covered in this Plan include hurricanes and storm surges, tornadoes and severe local storms, severe winter weather, river and flash floods, earthquakes, tsunamis, extreme fire weather, droughts, frosts and freezes, landslides and avalanches and volcanoes. Coordination of the multi-agency functions in warning services and community preparedness actions related to many of these disasters is carried out through a series of National plans. This Plan integrates the broad aspects of those more detailed plans such as the National Severe Local Storms Operations Plan, the National Hurricane Operations Plan, the National East Coast Winter Storms Operations Plan, the Federal Plan for a National Fire Weather Service, the Federal Plan for a National Agricultural Weather Service, the Federal Plan for Weather Radars and Remote Displays, the Federal Plan for Meteorological Data from Satellites and the Federal Plan for Meteorological Services and Supporting Research.

Part II - Findings, Goals and Objectives

GENERAL FINDINGS

The findings of the OEP Report to the Congress on Disaster Preparedness and the NACOA Report on the Agnes Floods and other recent post-disaster surveys have highlighted strengths and weaknesses of present efforts in natural disaster warning and preparedness and identified many unmet needs. The OEP Report states, "The value of past investment in prediction and warning capabilities is clearly demonstrable. Despite the increasing property losses, there has been a notable decline in lives lost where such capabilities have been established and used---." The NACOA Report found that, "The overall performance of the Nation's weather and flood warning system during tropical storm Agnes can be rated good. Though effectiveness was not uniform in all affected parts of the country, human performance must be credited with preventing critical system strains from turning into disaster. The benefit of hindsight points to some flaws and gaps in system capabilities of NOAA's storm prediction and flood data-gathering and warning system, to more serious deficiencies in the National capabilities for disseminating warnings and for anticipating public response to warnings---."

The U.S. operates the most extensive warning system in the world. Warnings are issued on hurricanes, tornadoes, severe storms, floods, and other atmospheric, hydrologic, and seismic hazards. These warning services are supported by national networks of monitoring and forecasting stations, and by communication links, aircraft, satellites, and computers. Hundreds of local offices insure dissemination of warning information. Nevertheless, many needs are, as yet, unmet. This Plan is directed toward correcting flaws and gaps in the system and satisfying needs.

The findings of the OEP Report and the NACOA Report can be grouped into two broad functional areas.

Warning System: Monitoring capabilities do not serve all potential disaster areas, and are inadequate to detect some significant small-scale phenomena, measure some important elements and communicate data fast enough. Warning and forecast preparation capabilities are not timely, accurate and complete. Warning dissemination is incomplete and slow.

Community Preparedness: Preparedness planning assistance to States and communities is growing but inadequacies continue to exist due to a lack of vulnerability and risk assessment information, and participation in planning programs.

SPECIFIC FINDINGS

The following is a list of specific findings which have identified unmet needs in warning services and community preparedness. These same findings are described in further detail along with programmed corrective actions in Section V of this Plan.

Monitoring:

- Tornadoes and other small-scale phenomena are not reliably detected in all cases.
- Weather radar coverage and use of data are not adequate.
- Satellite technology is not yet effectively exploited for early observation and dissemination of information on severe storm development.
- Hydrologic data networks are incomplete.
- Data collection is too slow and is not reliable.
- Dynamic forces within the earth's mantle are not fully monitored.
- Tsunami detection is inadequate.
- Reconnaissance aircraft need improved instrumentation and data relay capabilities.

Warning Preparation:

- Predictions of hurricane landfall and force are not accurate enough.
- Computer capacity is not adequate to develop and apply numerical hurricane prediction models.
- The resolution of numerical forecast models is not adequate to predict mesoscale features of major storms.
- Prediction of the potential of tornadoes is imprecise.
- The development and movement of hurricanes and tornadoes is not fully understood.
- River and flash flood prediction techniques are not adequate for all rivers.
- Quantitative precipitation forecasts are not accurate enough.
- Some River Forecast Centers do not receive adequate computer services.
- Staffs of River Forecast Centers are not adequate to provide services 24 hours per day.
- Management and coordination of system performance during major storms is not adequate.

- Prediction methods for earthquakes, volcanoes, landslides, and earthquake generated tsunamis are either not available or could be improved.

- Fire Weather Service is not available to all areas.

- An adequate, objective fire danger risk rating system is not yet available.

- Frost and freeze prediction and warning services are not available to all areas of the United States.

- Weather modification that may have a very favorable cost-benefit potential, e.g. in the modification of the intensity of hurricanes (Project STORMFURY) has not been fully explored.

- A major effort is required in the modeling of the dynamics of severe storms.

Warning Dissemination:

- Warning dissemination facilities are not complete.

- A 24-hour alerting capability is not available to all.

- National Warning System circuits are not fully used for interstate dissemination of warnings.

Community Preparedness:

- Vulnerability assessment programs do not always provide adequate support to community planning.

- The program of vulnerability and evacuation mapping has not been extended to all hurricane prone areas.

- The scale of river flood risk maps is too small for use by individual residents and the pace of the mapping programs is too slow.

- Land use controls and standards for structural engineering and materials in earthquake prone areas should be more widely used.

- The instrumentation network to support earthquake risk mapping is not adequate.

- The assessment of drought intensity as a means for coping with possible serious economic impacts is not fully used.

- Model or pilot preparedness plans are not available to some regions and for some types of disasters.

- Federal efforts to assist in the development of local disaster preparedness, e.g., establishment of local tornado preparedness training programs, are not adequate.

- Public information programs on disaster preparedness are inadequate.

- Technical assistance in establishing local flash flood warning systems is not always available.

GOALS

Effective warning services to the general public and responsive community preparedness must be attained so that through such warnings and preparedness lives and property can be protected, economic losses and human suffering mitigated and man's daily pursuits maintained to the maximum extent feasible under the awesome threat of natural disasters.

OBJECTIVES

The objectives of this Federal Plan are to document present and immediate future actions to be taken to:

- Achieve significant improvement in the accuracy and timeliness of natural disaster warnings.

- Expand the availability of disaster warnings to all in the United States who need them while simultaneously developing a highly selective capability to warn only threatened areas.

- Provide assistance in preparedness planning, including comprehensive natural hazard vulnerability assessment, to all communities in the United States.

Part III - Warning System

The warning system will be discussed under three functional headings--environmental monitoring, warning preparation, and warning dissemination. This division is convenient for discussing the Federal programs concerned with disaster warning services. However, the three functional areas and the programs they encompass are highly interdependent. These strong interrelationships dictate that the requirements and the programs developed to meet them be fully coordinated throughout the three functional areas to achieve maximum effectiveness and efficiency. This is particularly so when treating individual hazardous phenomena, such as hurricanes or earthquakes.

A. ENVIRONMENTAL MONITORING

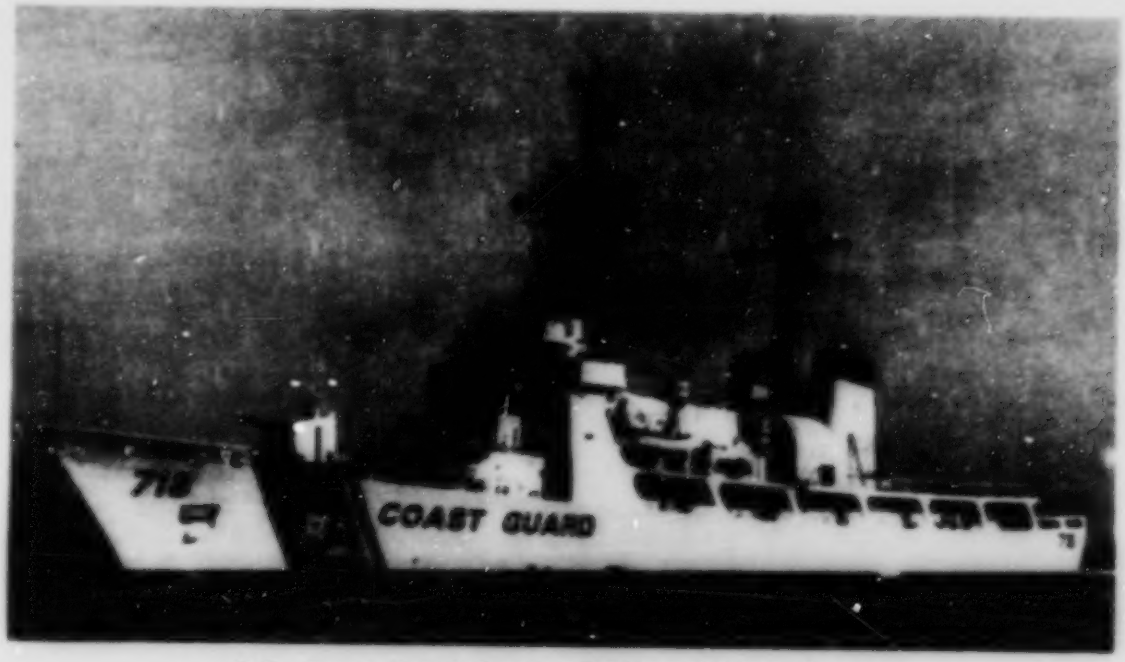
The warning system and certain aspects of community preparedness, such as vulnerability assessment rely upon environmental monitoring networks and capabilities. Without basic observed data on the environment, warning and assessment of environmental conditions would not be possible. Not an end in itself, monitoring is the foundation upon which these other activities must build. The monitoring networks need expansion to provide more reliable detection of critical parameters and phenomena; faster and more reliable data collection systems; and techniques and capabilities to fully exploit existing technology.

The effectiveness of warning services is totally dependent upon the continuous and reliable operation of a comprehensive and flexible monitoring system that can acquire information about the atmosphere, oceans, and land. The system must have a capability to sense concurrently environmental features on a local, regional, and global basis in order to identify the different scales and intensities of various phenomena. These requirements for a wide range of measurements and observations have resulted in a monitoring system that includes many elements.

Specific elements of the present and planned monitoring system are listed below with a brief description of their functions. Some of these elements have a multi-purpose capability to support specific disaster warning and assessment functions as well as day-to-day prediction services. These elements are marked with an asterisk and described in more detail following the list. These descriptions include a discussion of improvements that are planned to satisfy the needs identified by the OEP Report to Congress and in post disaster surveys. Other highly specialized monitoring networks that support warning and assessment functions pertaining to only one type disaster are discussed later. These special networks monitor landslides, earthquakes, tsunamis, volcanoes, frosts and freezes, droughts and extreme fire weather conditions.

Elements	Function
o *Geostationary Operational Environmental Satellites (GOES)	Provide a capability to detect severe storms from near-continuous cloud imagery over a broad area.
o *Radars	Provide continuous coverage of hazardous phenomena such as tornadoes, thunderstorms, severe local storms, hurricanes, and flash flood potential on a local and regional scale.
o *Hydrologic Network	Monitor rainfall amounts, river levels, temperature, and snow depths.
o *Coastal Stations	Monitor wind, pressure, precipitation, air and sea temperature, sea state and visibility.
o *Aerial Reconnaissance	Locate the center of and report profile data of temperature, wind and pressure for tropical cyclones and severe winter storms.
o Land Meteorological Network	Monitor variables of the atmosphere such as temperature, pressure, winds, visibility and precipitation at the surface.
o Upper Air Observation Network	Provide vertical profiles of pressure, temperature, water vapor, and wind conditions in the atmosphere.
o Offshore Facilities	Monitor wind, pressure, air and sea temperature, humidity, sea state, current and precipitation.
o Ships	Monitor variables in the atmosphere and ocean environments such as temperature and temperature profiles, pressure, wind, visibility, precipitation, sea state, salinity, currents, and ice conditions.
o Data Buoys	Monitor variables such as current, and temperature profiles in the lake, estuarine and oceanic environments; monitor surface wind, temperature, pressure, humidity and precipitation.

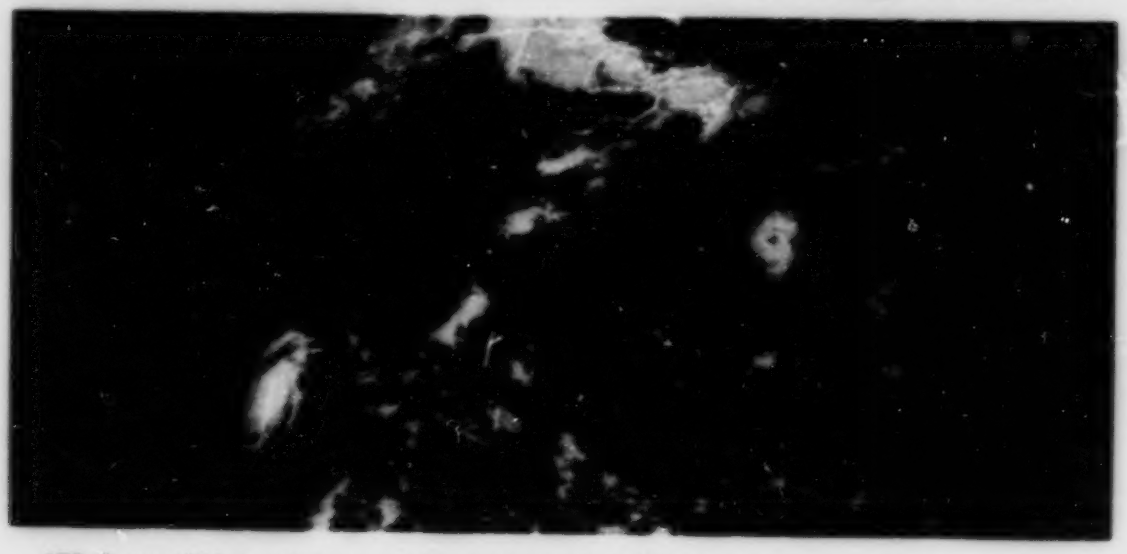
NOAA data buoy being towed to test and evaluation site by a U.S. Coast Guard Cutter.



U.S. Coast Guard Cutter CHASE, a high-endurance cutter of the type used as an Ocean Station.

Elements	Function
o Polar Orbiting Satellites.........	Provide a periodic capability to detect severe storms, vertical profiles of temperature, and the total atmospheric water vapor content in the column. Provide global cloud imagery, measurements of cloud-free areas, sea surface temperatures, related oceanic circulation features, and extent of sea ice.
o Seismological Network.............	Detect, identify, and locate local and distant earthquakes and alert the Tsunami Warning Center when major earthquakes occur.
o Strong Motion Network.............	Monitor strong motions of different types of ground conditions and their effects on man-made structures.

Standard building housing inflation shelter, and ground equipment of NOAA upper air observing station with rawinsonde train ready for release.



ATS-3 satellite picture of September 26, 1971, showing hurricanes Ginger in the Atlantic and Olivia in the Pacific.

Satellites

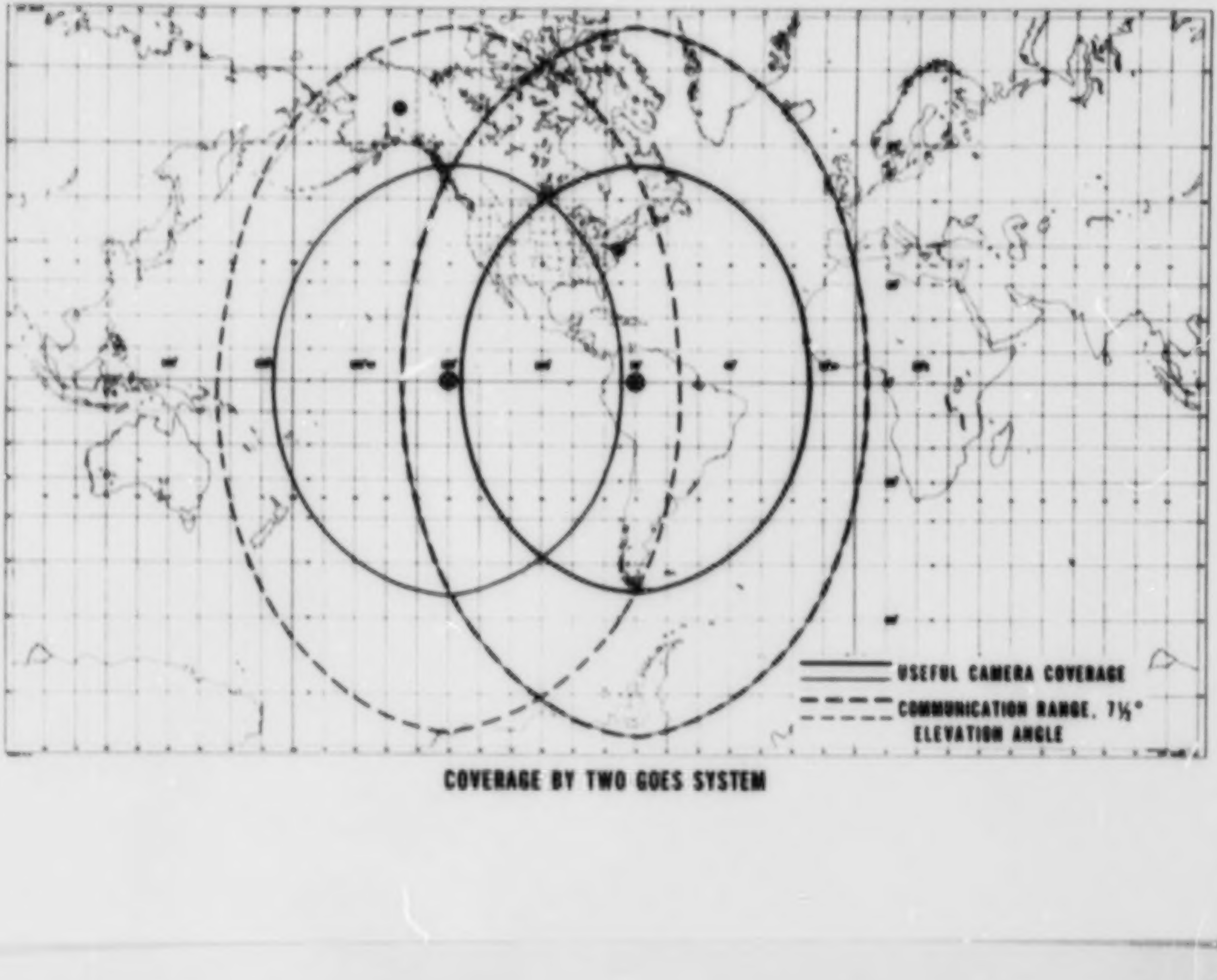
Among the most dramatic developments in recent years is the ability to collect vital environmental data from remote platforms in space. The polar orbiting satellites that have long demonstrated an operational ability to provide global weather observations have recently been significantly upgraded with new instrumentation. With the recent launch of the NOAA-2 polar orbiting operational satellite in October 1972, the first operational global temperature soundings are now available as a major supplement to ground based observations.

Research satellites in geostationary orbit have demonstrated a capability for near-continuous monitoring of weather over a large area.

The NASA Applications Technology Satellite (ATS-3) provides cloud pictures over the continental U.S., the western Atlantic and Gulf of Mexico at approximately 25-minute intervals during daylight hours. ATS-1 provided similar coverage of the eastern Pacific during its operational lifetime. Time-lapse movies are produced from these film sequences in near real-time and analyzed to determine movement and change in character of tropical disturbances. Wind fields at cloud level which are pertinent to the diagnosis and prognosis of the storm systems are derived also from these cloud motion observations. Information provided by satellites from data sparse tropical oceans contribute substantially to improved reliability and timeliness of the hurricane warning service. Some ATS satellite pictures are now available for analysis at the National Severe Storms Forecast Center within 30 minutes of their actual taking by the satellite. These pictures can be used to detect the early stages of severe storm development by monitoring the growth of distinctive cloud patterns before they can be detected by radar.

The outstanding success of the research ATS Satellites and the broad use of the data has evolved into a joint NASA-NOAA program to provide for a NOAA Geostationary Operational Environmental Satellite System (GOES). Based upon a successful series of NASA operational prototypes (the Synchronous Meteorological Satellites), GOES will be operated by NOAA as a two-satellite system by the summer of 1974. It will provide near-continuous picture coverage of the continental United States and adjacent ocean areas as shown on the accompanying chart. Real-time support to the hurricane centers at Miami, San Francisco, and Honolulu will be available through collocated Satellite Field Service Stations. In addition, a capability for near real-time observation and continuous monitoring of severe storm development, coordinated application of data through the use of radar-satellite mosaics, and video tape playbacks for detailed study of critical situations will be implemented.

Further extensive use of GOES is planned as a data relay for the real-time readout and use of data from automated observing platforms. This capability will contribute significantly to improving the timeliness of warnings, especially for tsunamis, severe storms, and some floods where warning times are critically short.



USEFUL CAMERA COVERAGE
COMMUNICATION RANGE, 7½°
ELEVATION ANGLE

COVERAGE BY TWO GOES SYSTEM

Weather Radar Net

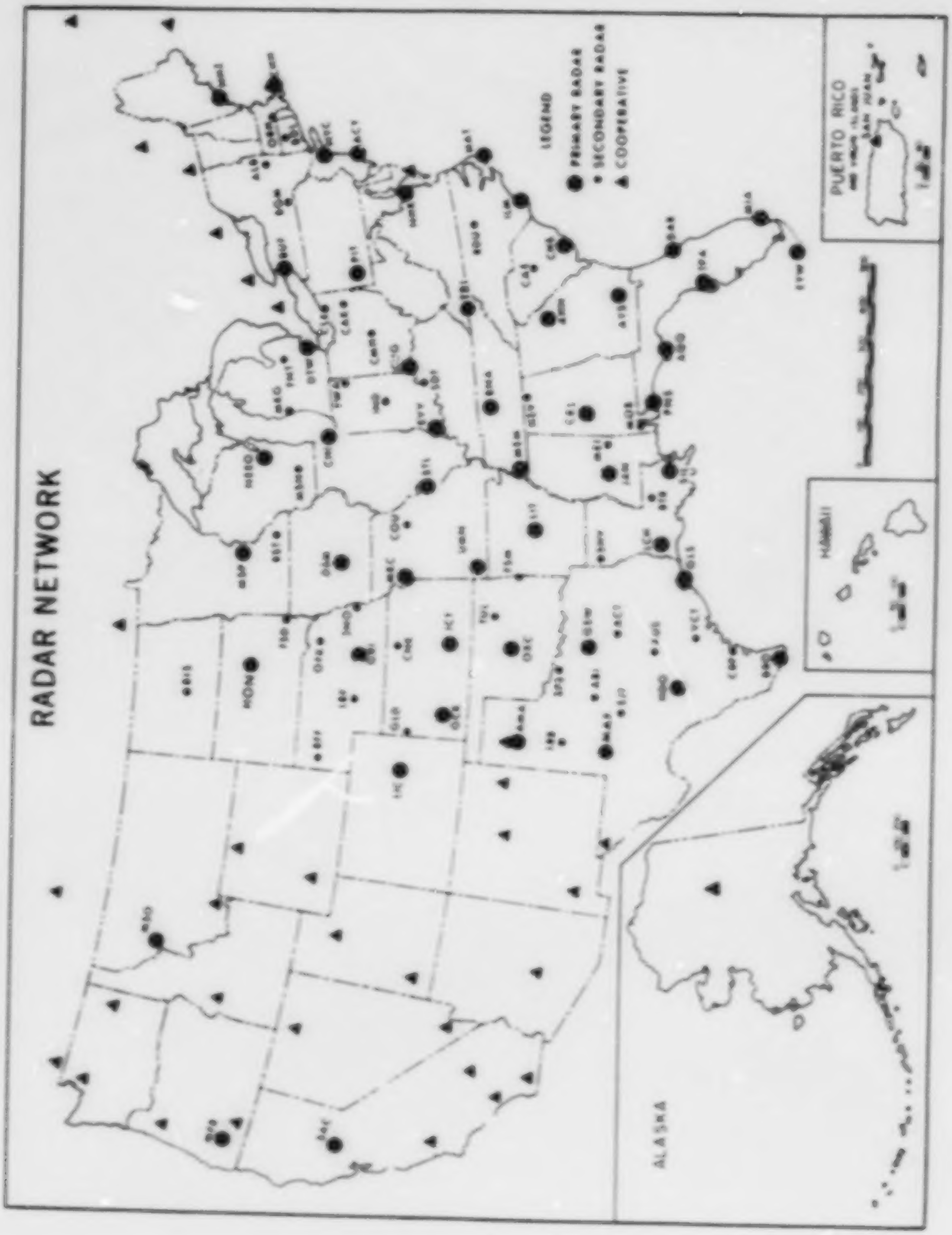
The National Weather Service relies heavily on radar to monitor small- and medium-scale features of potential disaster causing weather systems. Radar can be used to detect potentially severe thunderstorms and some tornadoes that occur. Areas of heavy rainfall can be located and monitored and approximate precipitation rates can be measured as an aid to flood forecasts and warnings. Radar installations along the coast are extremely useful in tracking hurricanes as they approach. Within a maximum distance of about 200 miles, long-range (WSR-57) radars show the location, size, shape and general intensity of the storm, from which speed and direction of movement can be determined.

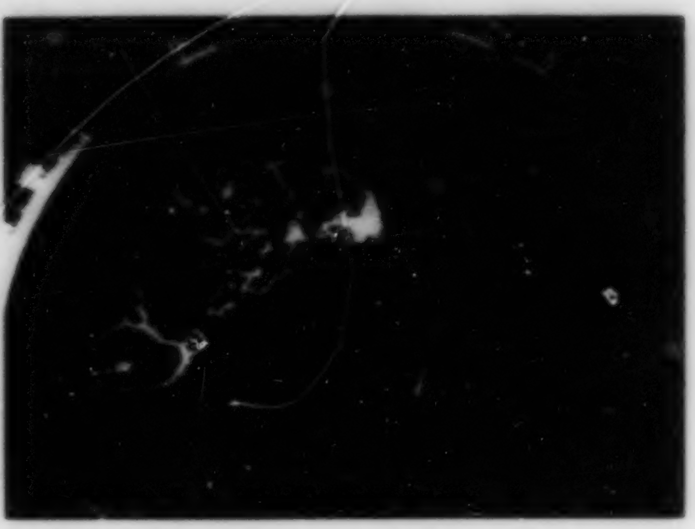
The basic concept of NOAA is that each office in areas prone to severe weather having a county warning responsibility should have direct access to radar information in the preparation of local storm warnings. WSR-57 and local warning radars are used for this purpose. In addition, the WSR-57 primary radar stations transmit hourly reports so that large-scale precipitation patterns can be determined to support routine analysis and forecast programs. Stations not equipped with radar are furnished direct support by remoting techniques from nearby primary radars.

The present network of National Weather Service radars is shown on an accompanying chart. It consists of 51 of the WSR-57 long-range network radars and 37 short-range local use radars. The WSR-57s were specially designed for storm detection and have a maximum effective range of about 200 miles. The local use radars are mostly modified World War II surplus military equipment with an effective range of about 100 miles. This older equipment is obsolete and expensive to maintain. Supplementary information is obtained from cooperative radars operated by the Federal Aviation Administration in the mountainous regions in the West and from Department of Defense radars.

Direct radar support to stations not equipped with radar is provided by one of three different methods. For short distances, a microwave link can be used to provide a signal to a repeater radarscope which continuously reproduces a high-quality radar presentation. For long distances, scan conversion transmission of radar scope pictures by standard telephone lines is used to provide a usable facsimile type copy. This method also offers the advantages of allowing a station with receiving equipment to dial-up and receive radar scope pictures from any station equipped to transmit. The third method used is standard facsimile transmission over established networks of hand-drawn replicas of scope presentations.

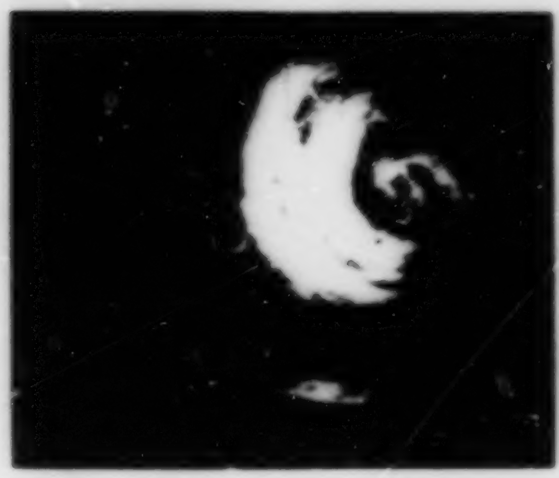
Planned improvements to the system will begin in FY 1974 with the procurement of 18 local use radars and the start of a three-year program to install two WSR-57 long-range network radars. The Federal Plan for Weather Radars and Remote Displays is now being updated. It will provide plans for additional radars, remoting devices, and the development and implementation of an automated system (D/RADEX) which will digitize radar data for improved applications and more rapid dissemination and assimilation.

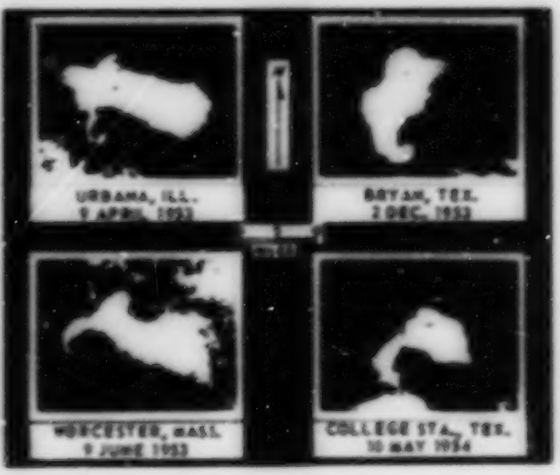

RADAR NETWORK
LEGEND
● PRIMARY RADAR
• SECONDARY RADAR
▲ COOPERATIVE
PUERTO RICO
SAN JUAN
HAWAII
ALASKA



Hook shaped echoes on weather radar indicating tornado activity.

Tower and plastic radome housing antennae of WSR-57 long-range weather radar.




URBANA, ILL.
9 APRIL 1953
BRYAN, TEX.
2 DEC. 1953
WORCESTER, MASS.
9 JUNE 1953
COLLEGE STA., TEX.
10 MAY 1954

Hurricane DORA 1964 as shown by WSR-57 Weather Radar at Daytona Beach, Fla.

WSR-57 weather radar scope picture showing contours of echo intensity by Video Integrated Processor (VIP).

To supplement the radar network in the detection of severe storms and tornadoes, strong dependence is placed on cooperative spotter reports from police and trained citizens. Local Weather Service Offices recruit and train volunteer severe local storm spotters in cooperation with city, county, and state offices to form networks of observing points. These networks are alerted on the basis of severe weather watch bulletins and observed radar echoes to watch for and report severe storms or tornadoes which they observe. It is planned to continue and expand the use of cooperative spotter networks.

Hydrologic Network

River District Offices (RDOs) of the National Weather Service administer and maintain the hydrologic network which supplies river and rainfall data to support the river and flood forecast services. They actively cooperate with field offices of the Corps of Engineers, Department of Agriculture and Department of Interior which supply additional data from observing stations they operate. The combined reporting networks of the participating agencies consist of some 5,500 rainfall and river gages, of which approximately 750 (15 percent) are equipped for telemetering data. The remainder of the stations are operated by cooperative observers (private citizens) who record the data and transmit it by telephone to the River District Office.

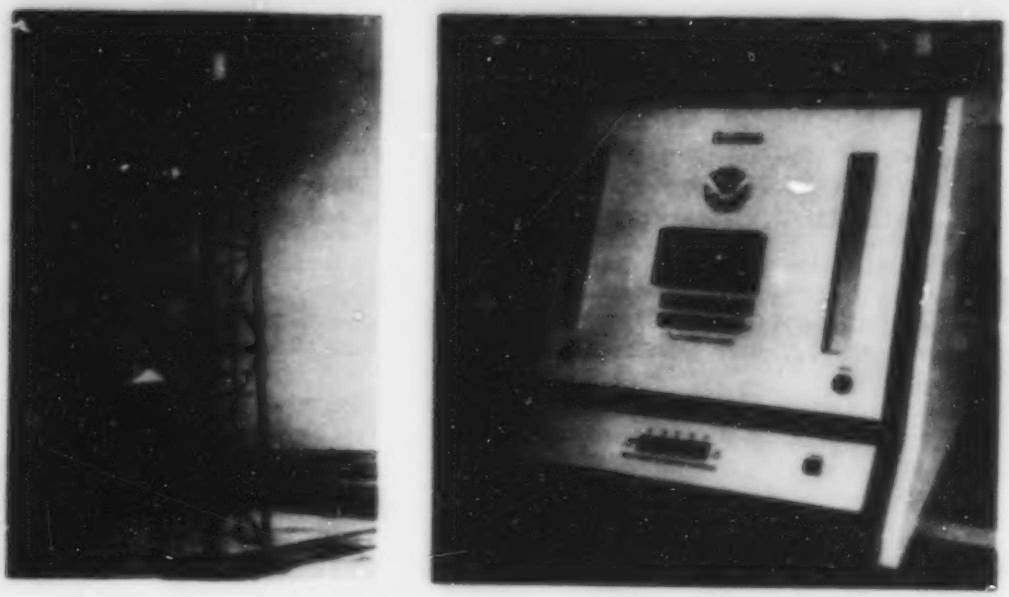
Data are routinely collected once or twice daily from all stations with significant rainfall within the hydrologic network. During critical situations when potential flood or flash flood situations exist, data are collected as frequently as the urgency of the situation requires and the collection system will permit. All data collected are forwarded to the River Forecast Centers (RFCs) for computer processing in the preparation of river forecasts and guidance material for the RDOs and Weather Service Forecast Offices.

Improvements to the system to provide better coverage and faster more reliable collection of data are planned within the next few years to add many new stations in flood-prone, mountainous areas. The river and rainfall gages will be automated with a remote readout capability in the RDOs and RFCs using Direct Distance Dial telephone or the GOES satellite. These new automated installations will be engineered to prevent destruction and minimize malfunction during floods of record depths.

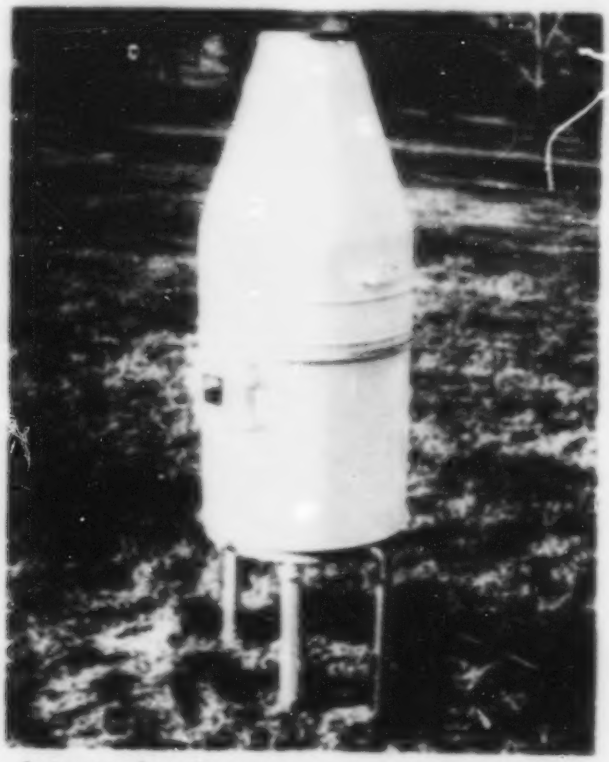
Coastal Station Nets

The basic land meteorological network has not provided the detailed data needed along the coasts when hurricanes or tropical storms are approaching. Two special observing networks of stations have been established to satisfy these requirements for special observations of the atmosphere and the sea.

The Cooperative Hurricane Reporting Network (CHURN) consists of 130 stations spaced about 25 miles apart along the Gulf of Mexico and Atlantic coasts, most of which are operated by the Coast Guard. All CHURN stations operated by civilians make one observation each day near 7 a.m. local standard time. CHURN stations operated by the Coast Guard routinely furnish 3 or 6 hourly



Automatic weather stations provide surface meteorological data from remote or unmanned locations.



Automated rain gage used as part of the hydrologic observing network to acquire data from remote locations.

observations of wind, sea and weather to satisfy requirements of the coastal marine forecast program. During periods of threatening weather, all CHURN stations take and transmit surface observations at increased frequency upon request of the National Weather Service in direct support of the warning function. Under tropical storm or hurricane conditions, hourly reports are required for short periods.

The Tide Height Reporting Network consists of 140 coastal stations that make special tide observations to support the preparation of storm tide warnings during potential or actual tropical storm or hurricane situations. Weather offices call these stations whenever observations are needed. In addition, 35 tide gages provide telemetered tide information to 28 coastal weather offices 24 hours a day. The forecaster uses this information on water levels, tides and waves to issue detailed warnings to the public and concerned special interests along the coast in his local area of responsibility.

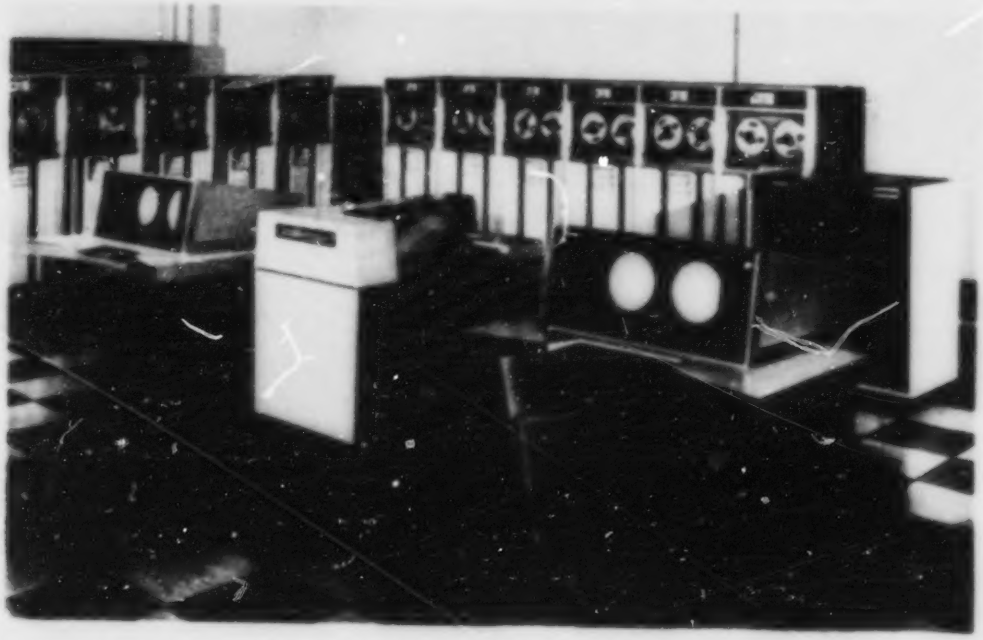
Both of these special networks are programmed to continue. Additional automated tide and wave gages will be installed and automatic weather stations will be used to provide continued observations from Coast Guard facilities that are being converted from manual to automated operations.

Aerial Reconnaissance

Aerial reconnaissance is used extensively to collect data on tropical disturbances and severe winter storms, and in weather modification experiments and operations. Reconnaissance aircraft, primarily of the Department of Defense, penetrate all tropical disturbances that are within range, providing center fixes and profiles of temperature, wind, and pressure, and reports on cloud structure. These data are essential to NOAA's National Hurricane Center to predict accurately the movement and intensity of tropical cyclones and to issue timely and accurate warnings. In addition, the data are used in research on the dynamics of hurricanes. Reconnaissance is also flown on severe winter storms along the East Coast of the United States in support of forecasts and warnings of these phenomena. NOAA aircraft are used primarily for weather modification experiments and to collect data in support of research requirements. When major experiments or projects such as "Stormfury" (Hurricane modification experiment) exceed NOAA's reconnaissance capability, support is furnished by the DOD on a reimbursable basis.

Planned system improvements in support of Project Stormfury in the Pacific in 1976 include modernization of the NOAA aircraft fleet by phased replacement of obsolete aircraft and development and use of improved instrumentation and data relay systems in both Air Weather Service and NOAA reconnaissance aircraft. The system has capabilities similar to that with which Navy hurricane reconnaissance aircraft are now equipped, and will offer improved capabilities for hurricane monitoring by providing: more accurate horizontal profile measurements, particularly flight level winds, more accurate storm fixes by improved navigation, and automated recording and transmission of observed profile data. In addition, a system under development by the U.S. Air Force is being considered for installation in their aircraft for operational hurricane reconnaissance. If installed it would provide capabilities for routine reconnaissance equal to that used in weather modification experiments and research. The Air Force has a program underway to add weather radars to the Atlantic hurricane aircraft.

WC-130, DoD weather reconnaissance aircraft operated by Air Weather Service, USAF.



Computers at the National Meteorological Center.

B. WARNING PREPARATION

The basic concept under which the National Weather Service of the National Oceanic and Atmospheric Administration issues forecasts and warnings is essentially the same for all types of atmospheric natural disasters. The National Meteorological Center (NMC) prepares large-scale analyses and forecasts which are disseminated by facsimile and teletypewriter networks for use as the basic guidance for the entire forecast and warning service. Similarly the National Environmental Satellite Service (NESS) supplies centralized support to the system in the form of processed satellite data.

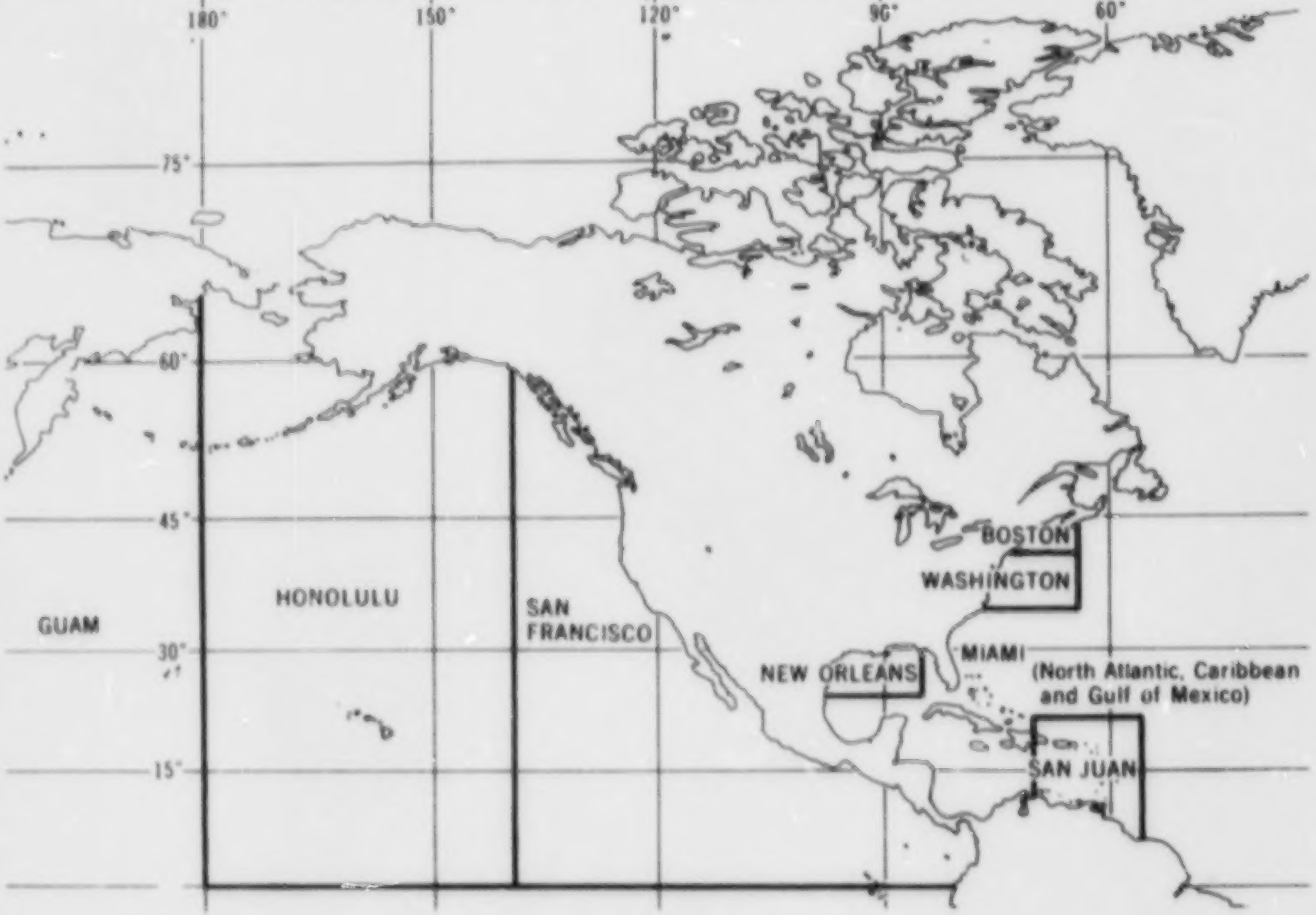
Computer capabilities are essential to process the large volume of useful data and to accommodate the more advanced numerical forecasting techniques. The NMC and NESS now use a third generation computer system to provide centralized basic analysis and forecast support to the system. Fourth and fifth generation computer systems will be required to continue the development, testing and application of satellite data assimilation methods and improved numerical models. Less powerful computer systems are used in river and flood forecasting by the RFCs whereas mini-computers are used by upper air observing stations for data reduction computations.

More detailed analysis and forecast guidance is issued by twenty special offices of the National Weather Service. Hurricane advisories, watches, and warnings are issued by seven Hurricane Warning Offices for their designated areas of responsibility. River stage and flood forecasts and guidance material on flash flood potential are issued by twelve River Forecast Centers (RFC). The National Severe Storms Forecast Center is responsible for preparing and releasing tornado and severe thunderstorm watches which include information for public use and aviation interests.

The basic forecast and warning responsibility for each state is assigned to one of forty-three Weather Service Forecast Offices (WSFO) and the final warning responsibility for each county in the United States is assigned to a WSFO or Weather Service Office (WSO). The WSFOs and WSOs use the guidance from NMC and the special Forecast Centers and Warning Offices and all available reports and special observations to prepare and issue detailed warnings to the general public and government offices in the area for which they have warning responsibility. Within each National Weather Service Region a Warning Coordination Center or Regional Warning Coordination Center is responsible for coordination and consistency of forecasts and warnings issued within the Region.

A post-event survey of all aspects of the warning services and community preparedness functions is conducted following each significant storm or flood. These surveys provide management at all levels with a means of evaluating the effectiveness of the total services and the performance of integral parts of the system and the offices and individuals involved. Actions taken on the findings of the surveys are followed-up by the responsible program managers to insure that appropriate program adjustments are made to satisfy unmet needs in the system.

HURRICANE WARNING OFFICES · AREAS OF RESPONSIBILITY


180°
150°
120°
90°
60°
75°
60°
45°
30°
15°
GUAM
HONOLULU
SAN FRANCISCO
BOSTON
WASHINGTON
NEW ORLEANS
MIAMI
(North Atlantic, Caribbean and Gulf of Mexico)
SAN JUAN

This portion of the plan will focus on warning preparation and relevant research and development. Each type natural disaster is treated separately in the discussions that follow.

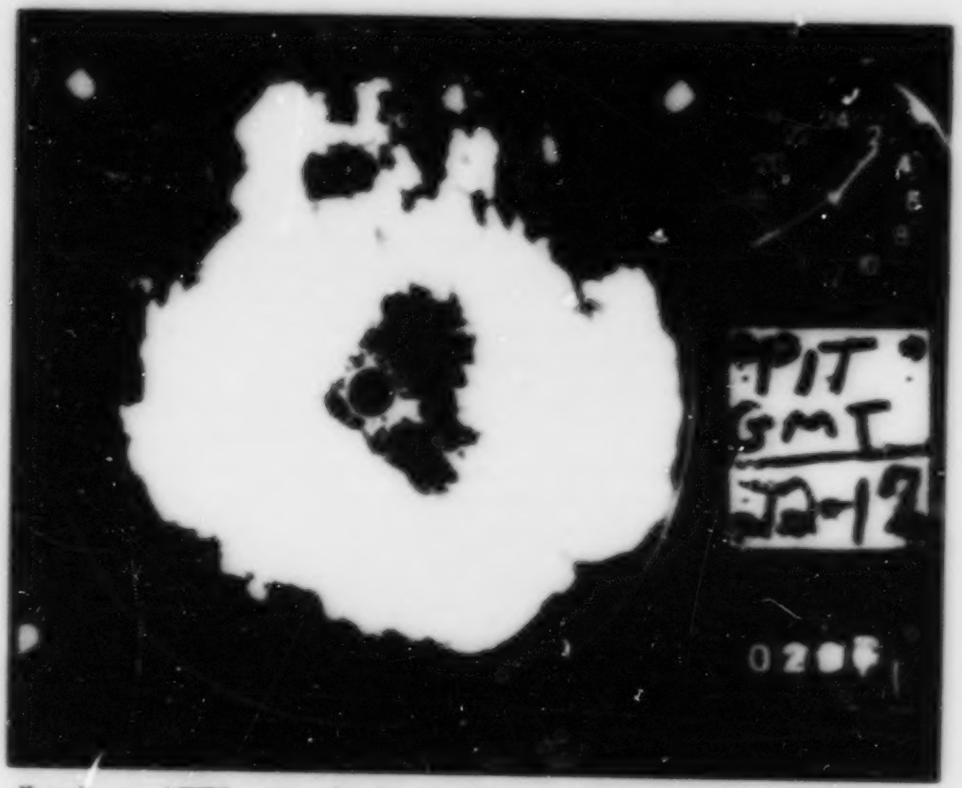
HURRICANES AND STORM SURGES

Hurricanes and typhoons form over warm tropical oceans and threaten death and destruction over areas exposed to their path. Most of the damage in coastal areas is due to the surge of wind driven waves and abnormally high tides but high winds contribute substantially to the losses. Although hurricanes and typhoons tend to dissipate as they move over land, very often they produce heavy rains causing extensive flooding over inland areas along the storm track and are frequently accompanied by devastating tornadoes adding immeasurably to the destruction potential. The overall effectiveness of the hurricane warning service is in large part dependent on a family of monitoring systems already discussed--satellites, aerial reconnaissance and radar. Satellites provide a capability to detect tropical storms in their earliest stages of formation and monitor their general development and movement while they are far from land. Aerial reconnaissance provides more accurate fixes on storm positions and detailed information on pressure, temperature and wind velocity. These data are essential to the preparation of accurate forecasts of hurricane movement and force and are, therefore, vitally important as storms near the coast. Central pressure which can be obtained only by reconnaissance is of particular importance in forecasting storm intensities. Radar stations along the coast continually monitor a hurricane's position and movement during the critical period of landfall. They furnish information on storm structure and areas and approximate intensities of rainfall that are needed for forecasting severe local storms and floods as the hurricane moves inland.

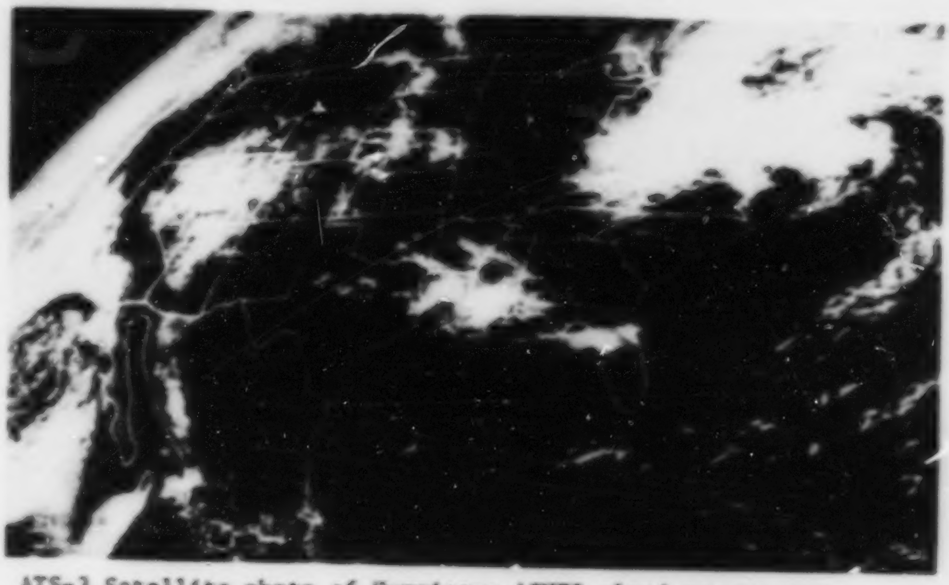
Improved hurricane forecasts and warnings are needed to fully satisfy the needs of the general public and community preparedness planners. Errors in predicted landfall and force cause unnecessarily large areas to be warned resulting in undue evacuation and boarding-up costs. Additional research and a greater computer capability are needed to develop and test improved statistical and numerical prediction techniques to achieve the needed improvements.

Forecasts and Warnings

Three Hurricane Centers and four Hurricane Warning Offices comprise the core of the Hurricane Warning Service. The Hurricane Centers located at Miami, San Francisco, and Honolulu are responsible for hurricane analysis and prediction in assigned areas of responsibility. Hurricane Warning Offices are located at Boston, Massachusetts, Washington, D. C., New Orleans, Louisiana, and San Juan, Puerto Rico. Both the Hurricane Centers and the Warning Offices have warning responsibility for their assigned areas. The Hurricane Centers are also responsible for providing a hurricane forecast and warning service to international interests in their areas and for coordination with designated offices of the United States military services on operational



Hurricane AGNES rain clouds as shown by WSR-57 weather radar at Pittsburgh, Pa., June 22, 1972.



ATS-3 Satellite photo of Hurricane AGNES cloud masses over Northeastern States on June 22, 1972.

matters pertaining to aerial hurricane reconnaissance and hurricane forecasts and warnings. In addition, Miami, which is designated the National Hurricane Center (NHC), coordinates the warning functions of the four Warning Offices. The final warning responsibility for each county is assigned to a Weather Service Forecast Office (WSFO) or Weather Service Office (WSO).

Much of the analysis work is still being done manually at all three Centers as is the forecasting at the Centers responsible for the Pacific areas. However, at the NHC, Miami, computer capabilities have been implemented to automate data handling, chart plotting, forecasting hurricane tracks, determining watch areas, and for forecasting storm tides. The NHC analog-statistical technique is used for determining hurricane watch areas and another computer technique is used for obtaining an objective forecast of storm tides. These computer outputs are used in the preparation of advisories and bulletins for dissemination via multiple communications networks discussed later in this Plan. The Hurricane Warning Offices at Boston, Washington, New Orleans, and San Juan also have access to these computer outputs either directly or by relay through NHC Miami for use in the preparation of advisories and bulletins for their areas.

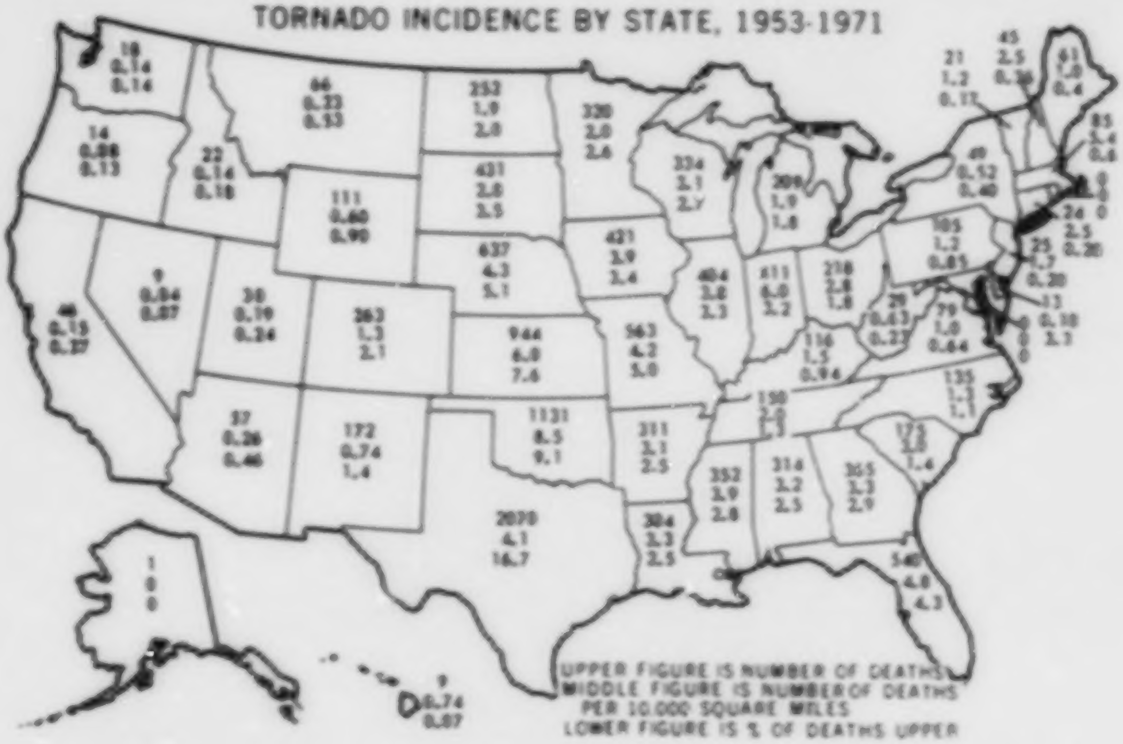
Hurricane advisories are normally issued by the appropriate Center or Warning Office three times daily for distribution to the general public. However, they may be issued more frequently, especially when severe storms are nearing the coast. A telephone hotline connecting the NHC, Hurricane Warning Offices and WSFOs is used to coordinate advisories and warnings issued for areas along the Gulf and Atlantic Coasts. Advisories give specific information on the storm's position, intensity, direction and speed of movement, and designate areas of the coast that are under a hurricane watch or warning. WSFOs and WSOs with warning responsibility ensure local dissemination of advisories and bulletins and are responsible for informing all interests on local effects of the hurricane and alerting them to the need for emergency action if it becomes necessary. Each office with warning responsibility is being equipped with emergency power and communications to insure continued operation during emergencies.

Research

The National Oceanic and Atmospheric Administration (NOAA) and the National Science Foundation (NSF) support hurricane research. NOAA's efforts are directed primarily toward the development of techniques for hurricane prediction and modification while the NSF programs are designed to improve basic knowledge and theory of hurricane structure and development.

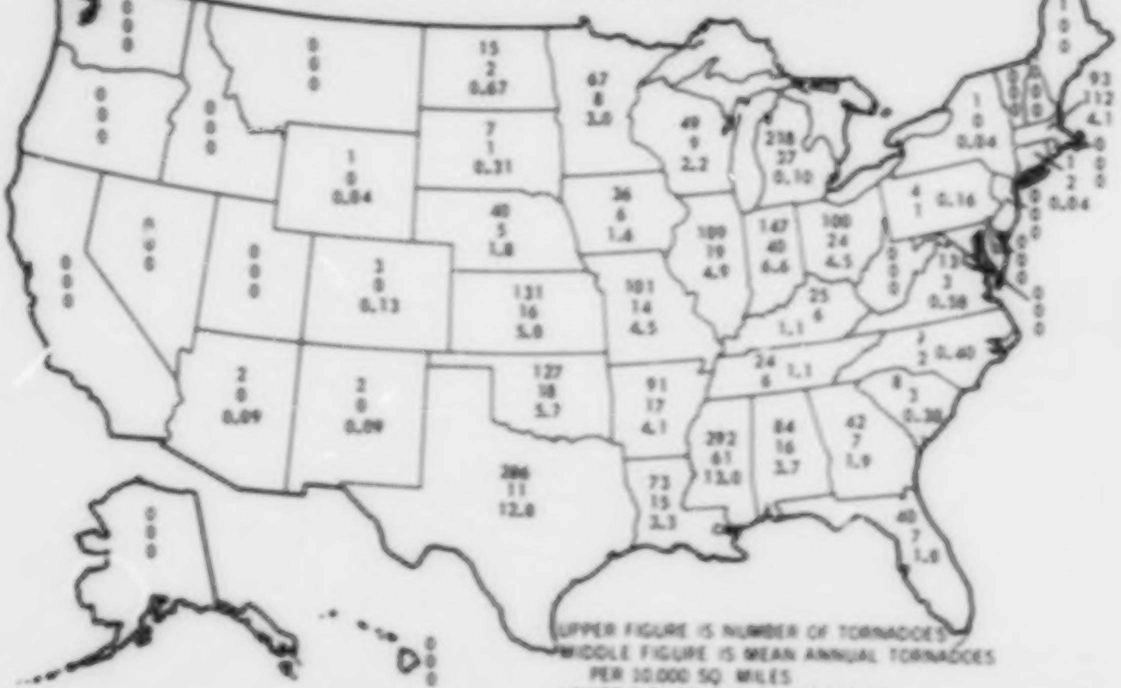
NOAA has developed a primitive equation, asymmetric, 3-dimensional hurricane prediction model that uses real input data. This model has shown promising results, using past data sets, in predicting both track and development of hurricanes and easterly waves. Work is continuing to reduce the large amount of computing time required for the model to make a 36-to 48-hour prediction. Currently, severe constraints on the use of such models relate to initial value problems, and accurate data acquisition and analysis on the scale

TORNADO INCIDENCE BY STATE, 1953-1971


18 0.14 0.14
14 0.08 0.13
22 0.14 0.10
66 0.23 0.53
252 1.0 2.0
320 2.0 2.6
431 2.0 3.5
111 0.60 0.90
637 4.3 5.1
421 3.9 3.4
334 2.1 2.7
209 1.9 1.8
9 0.04 0.07
30 0.19 0.24
263 1.3 2.1
46 0.15 0.37
944 6.0 7.6
563 4.2 5.0
404 3.8 3.3
411 6.0 3.2
218 2.8 1.8
105 1.2 0.85
49 0.52 0.40
21 1.2 0.17
45 2.5 0.36
61 1.0 0.4
85 3.4 0.6
24 2.5 0.20
25 1.7 0.20
13 0.10 2.1
79 1.0 0.64
20 0.63 0.23
116 1.5 0.94
135 1.3 1.1
150 2.0 1.3
37 0.26 0.46
172 0.74 1.4
1131 8.5 9.1
311 3.1 2.5
352 3.9 2.8
314 3.2 2.5
305 3.3 2.9
173 3.0 1.4
2070 4.1 16.7
304 3.3 2.5
540 4.8 4.3
1 0 0
9 0.74 0.07

UPPER FIGURE IS NUMBER OF DEATHS
MIDDLE FIGURE IS NUMBER OF DEATHS
PER 10,000 SQUARE MILES
LOWER FIGURE IS % OF DEATHS UPPER

DEATHS FROM TORNADOES, 1953-1971


0 0 0
0 0 0
0 0 0
0 0 0
15 2 0.67
67 8 3.0
7 1 0.31
1 0 0.04
49 9 2.2
218 27 0.10
1 0 0.04
1 0 0
93 112 4.1
1 2 0.04
40 5 1.8
36 6 1.6
4 1 0.16
0 0 0
3 0 0.13
131 16 5.0
101 14 4.5
100 19 4.9
147 40 6.6
100 24 4.5
13 2 0.58
25 6 1.1
2 2 0.40
24 6 1.1
2 0 0.09
2 0 0.09
127 18 5.7
91 17 4.1
8 3 0.38
292 61 13.0
84 16 3.7
42 7 1.9
286 11 12.8
73 15 3.3
40 7 1.8

UPPER FIGURE IS NUMBER OF TORNADOES
MIDDLE FIGURE IS MEAN ANNUAL TORNADOES
PER 10,000 SQ. MILES
LOWER FIGURE IS % OF TORNADOES

required. Improved data collection capabilities and more research are needed to solve the problems in these areas before the model can be applied operationally. Additional research is being done on other aspects of the asymmetric hurricane model. Further automated techniques are being developed which will permit real-time use of aircraft reconnaissance data and digital radar data in numerical predictions. Intensive efforts will also be directed to finding new techniques for the use of satellite data in both numerical prediction and subjective forecasting methods.

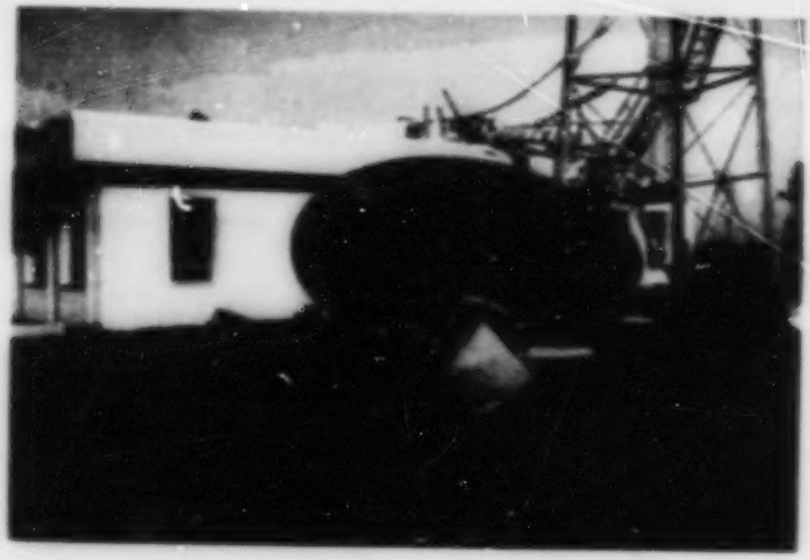
TORNADOES AND SEVERE LOCAL STORMS

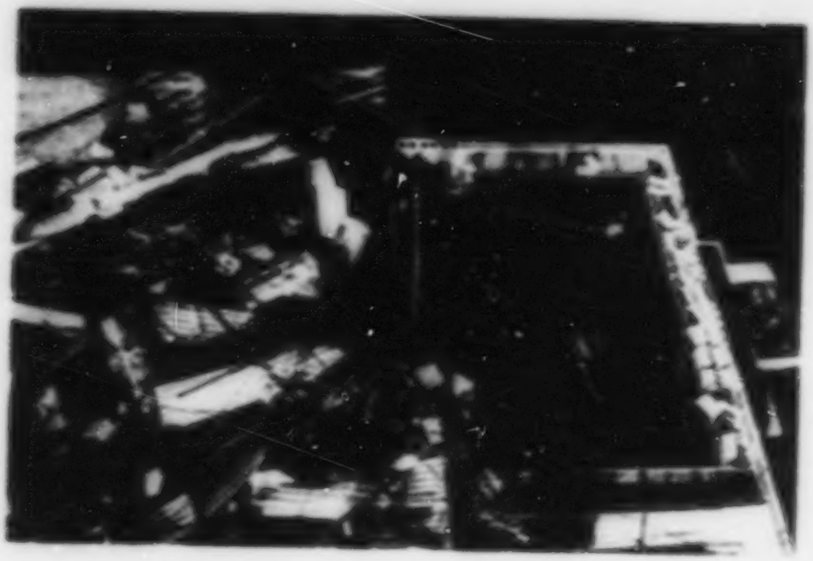
Tornadoes are the smallest and most violent of all storms. Although they average only one-eighth of a mile in width and seldom travel more than five miles during their short life span, they caused from June 1963 to July 1970, 868 deaths, 13,954 injuries and $1,494 million in property damage. Tornadoes are most frequent in the mid-west during the spring and early summer but they have occurred in every State and month of the year. Since tornadoes are difficult to predict and detect, the NWS uses a system of watches and warnings to alert the public--watches for areas where tornadoes are expected to develop--warnings when they have been visually sighted or strongly indicated by radar. Although many advances have been made in severe storm prediction techniques in recent years, much research is needed on the basic dynamics and modeling of convective storms as a means of developing improved forecasting techniques to provide more accurate and timely warnings. Satellite data, particularly from geostationary satellites, must be more fully exploited in tornado and severe thunderstorm forecasting.

Forecasts and Warnings

The NOAA National Severe Storms Forecast Center (NSSFC) provides a single source for severe thunderstorm and tornado watches in the United States. Operating procedures and cooperative agreements with other Departments and agencies are published annually in the National Severe Local Storms Operations Plan. The Center uses the broad-scale analyses and prognoses prepared by the National Meteorological Center supplemented by locally prepared detailed analyses and statistically derived indices for severe weather prediction. The Center prepares and releases 24-hour severe local storm outlooks and shorter range forecasts that designate watch areas where the likelihood of severe thunderstorms or tornadoes is high.

Watch messages are disseminated by the Radar Report and Warning Coordination Circuit (RAWARC), Service A, press wire services and the NOAA Weather Wire Service. Guidance material is transmitted by RAWARC, Service A, and the National Facsimile Circuit.





WSR-57 Weather radar at the Meteorological Observatory, Centerville, Alabama was extensively damaged by a tornado May 27, 1973.

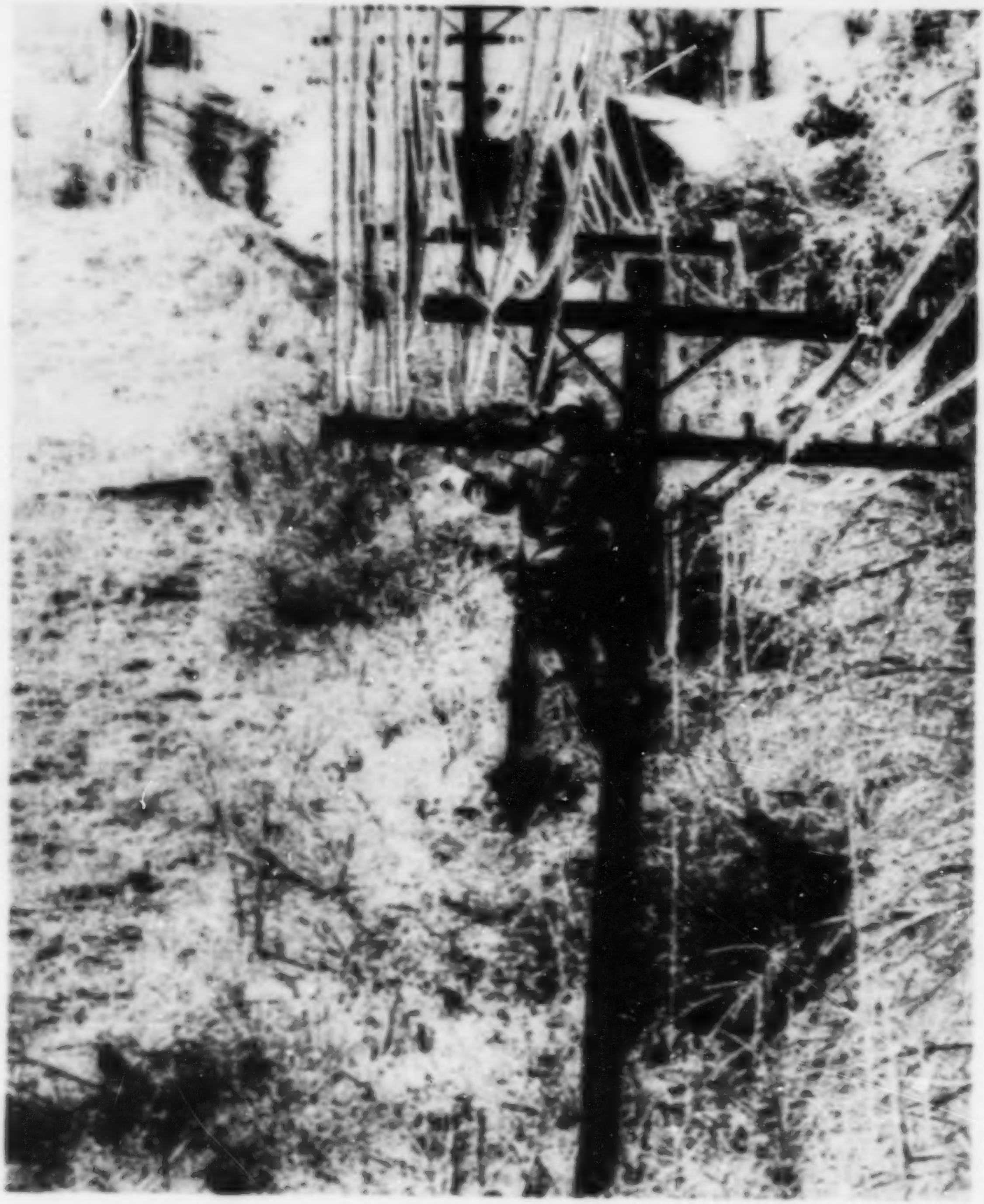
Weather Service Offices use the severe weather watches and guidance material issued by NSSFC, as a basis for alerting spotter networks and the preparation of defining statements of the watch bulletins which specify the affected areas in terms of counties, towns, and locally well-known geographic landmarks. These messages are disseminated by multiple means to the public, and to local government, law enforcement, and emergency agencies. When a tornado or severe storm is sighted or identified by radar, an appropriate warning is issued which describes the location of the severe storm or tornado when it was detected, the area that could be affected, and the time period covered by the warning.

In 1974, the staff of the NSSFC will be increased and special ground equipment added to permit exploitation of satellite data in the preparation of tornado and severe thunderstorm forecasts. The use of three-dimensional and small-scale analyses to identify mesoscale features associated with severe storms will be increased. The timeliness of warnings will be improved with the implementation of automation programs which will provide for data collection, computer processing and message preparation and transmission. In addition, emergency power and communications equipment will be installed at all offices with warning responsibility to insure continuous operations during power failures and communications equipment breakdowns.

Research

The Meteorology Program under the National Science Foundation supports projects aimed at developing a better understanding of severe thunderstorms and tornadoes. Particular attention is directed to modeling of convective storms, mesoscale structure of weather systems, and the nature and behavior of tornadoes. Related to these are several programs of studies of the nature of lightning strokes and the physical processes that generate them. The Engineering Mechanics Section has developed a wind engineering program that includes substantial support in the fluid dynamics of cyclonic winds; their formation, development, movement, and interaction with topographic and physical structures.

NOAA will continue work to develop a three-dimensional numerical model to better understand the internal physics and dynamics of storms. In addition, programs in basic and applied research will be continued to develop a better understanding of tornadoes, thunderstorms and squall lines as a basis for improving forecasting techniques. Programs of intensive observation of severe storms will be continued by the NOAA National Severe Storms Laboratory (NSSL) from a dense network of weather stations, an instrumented tower, serial releases of rawinsondes, conventional and Doppler weather radars, electric field monitors and specially instrumented aircraft. Other efforts within NOAA involve research and development work conducted on the application of acoustic and optical techniques to the remote sensing of low-level temperature and wind profiles and precipitable water. A project which has shown preliminary promise of success to identify tornadoes by their electromagnetic signature will also continue.



ICE - A threat of severe winter storms causes millions of dollars damage each year to overhead transmission lines.
Springfield, Mo., December 1972

SEVERE WINTER WEATHER

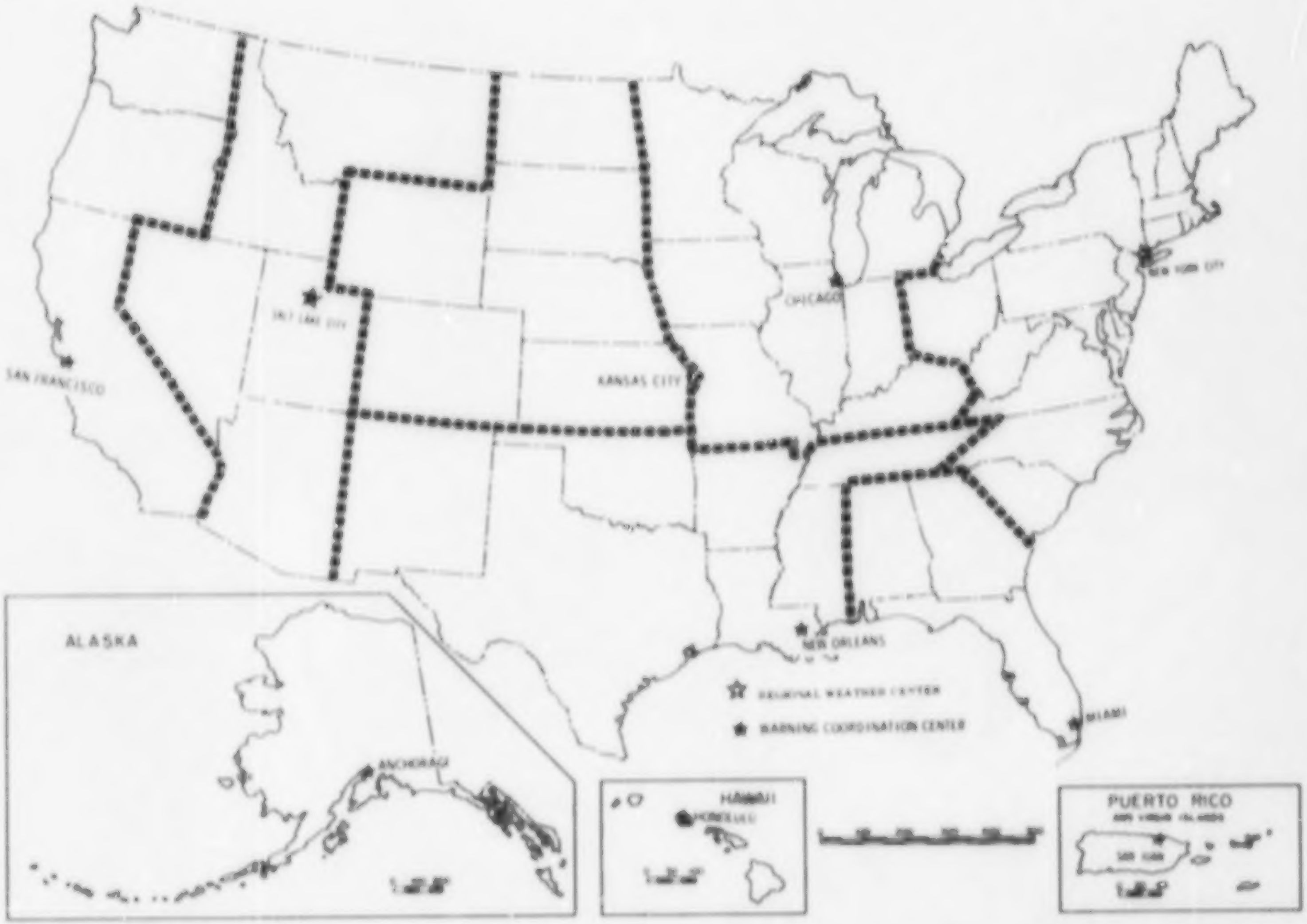
A severe winter storm may paralyze large metropolitan areas for one or more days and cause huge economic losses in industry, agriculture, and ranching interests. The loss of lives in winter storms is also significant. The average annual death toll in winter storms is 88 versus 62 in hurricanes. Winter storms include several types of severe weather--blizzards, heavy snow, freezing rain, cold waves, frosts and freezes, storm tides, and high winds. The management and coordination of the system performance during major storms needs to be improved to insure that significant unexpected developments are recognized early and that updated forecasts are issued promptly.

Forecasts and Warnings

The National Meteorological Center (NMC) has responsibility for the large-scale analysis program and the provision of guidance forecast information pertaining to winter storms for the United States. The NMC Quantitative Precipitation Forecast (QPF) Unit provides guidance charts for use in the issuance of heavy snow watches and warnings. These guidance products are utilized by Weather Service Forecast Offices which prepare and issue forecasts two times daily for their respective state areas of responsibility. Additional zone forecasts are provided three times daily, and very short term forecasts are provided by Weather Service Offices for their local areas of responsibility. Revised forecasts are issued as required. New computer techniques such as the model now under development at NMC which uses a finer data resolution for computations and numerical prognoses will provide a more refined analysis and forecast chart.

Winter weather warnings are prepared by Weather Service Forecast Offices (WSFO) and coordinated by the appropriate Warning Coordination Center (WCC). Areas of responsibility for these ten WCCs are shown on an accompanying chart. WSFOs and the WCCs maintain a continuous surveillance of assigned areas of responsibility to detect developing severe winter weather and track severe winter storms. Warning bulletins and statements on the storms are issued for the press, radio and television stations to alert the public, public officials and all interests concerned. Weather Service Offices issue local winter weather warning statements (coordinated with responsible WSFO) and are responsible for ensuring local distribution of the warnings and bulletins to the press, radio, television, local officials, and disaster agencies. These statements are issued to provide information about specific local effects of the storm.

A major reorganization of the management system for forecasts and warnings is now underway and will be completed during FY 1973. In the planned system a Regional Warning Coordination Center (RWCC) will be established in each of the four NWS Regions to replace the WCC's in the contiguous U.S. These RWCCs will have the functions of monitoring major storm systems and coordinating local forecasts issued by offices in their respective areas of responsibility. This will provide greatly improved system performance evaluation and management over that formerly provided.


SAN FRANCISCO
SALT LAKE CITY
KANSAS CITY
CHICAGO
NEW YORK CITY
NEW ORLEANS
MIAMI
REGIONAL WEATHER CENTER
WARNING COORDINATION CENTER
ALASKA
ANCHORAGE
HAWAII
HONOLULU
PUERTO RICO
AND VIRGIN ISLANDS
SAN JUAN

REGIONAL WEATHER AND WARNING COORDINATION CENTERS AND AREAS

Message preparation and communication procedures within weather offices are planned to be automated to speed-up the preparation, updating, and transmission of warnings to insure better intra-area coordination and consistency of forecasts. This planned long-term improvement would be made available through the Automation of Field Operations Services (AFOS) program which is under development by NOAA. As AFOS is now proposed, each Weather Service Forecast Office would have a mini-computer with a capability for electronic storage and automated screening and call-up of all alpha-numeric and graphic data now processed by hand. Interconnecting high-speed communication circuits would allow rapid interchange of data and coordination of warnings. The same mini-computer system would automatically collect and monitor observations from within the WSFO's area of responsibility, and automatically route forecasts and warnings to the various dissemination channels, such as NOAA Weather Wire Service and CATV.

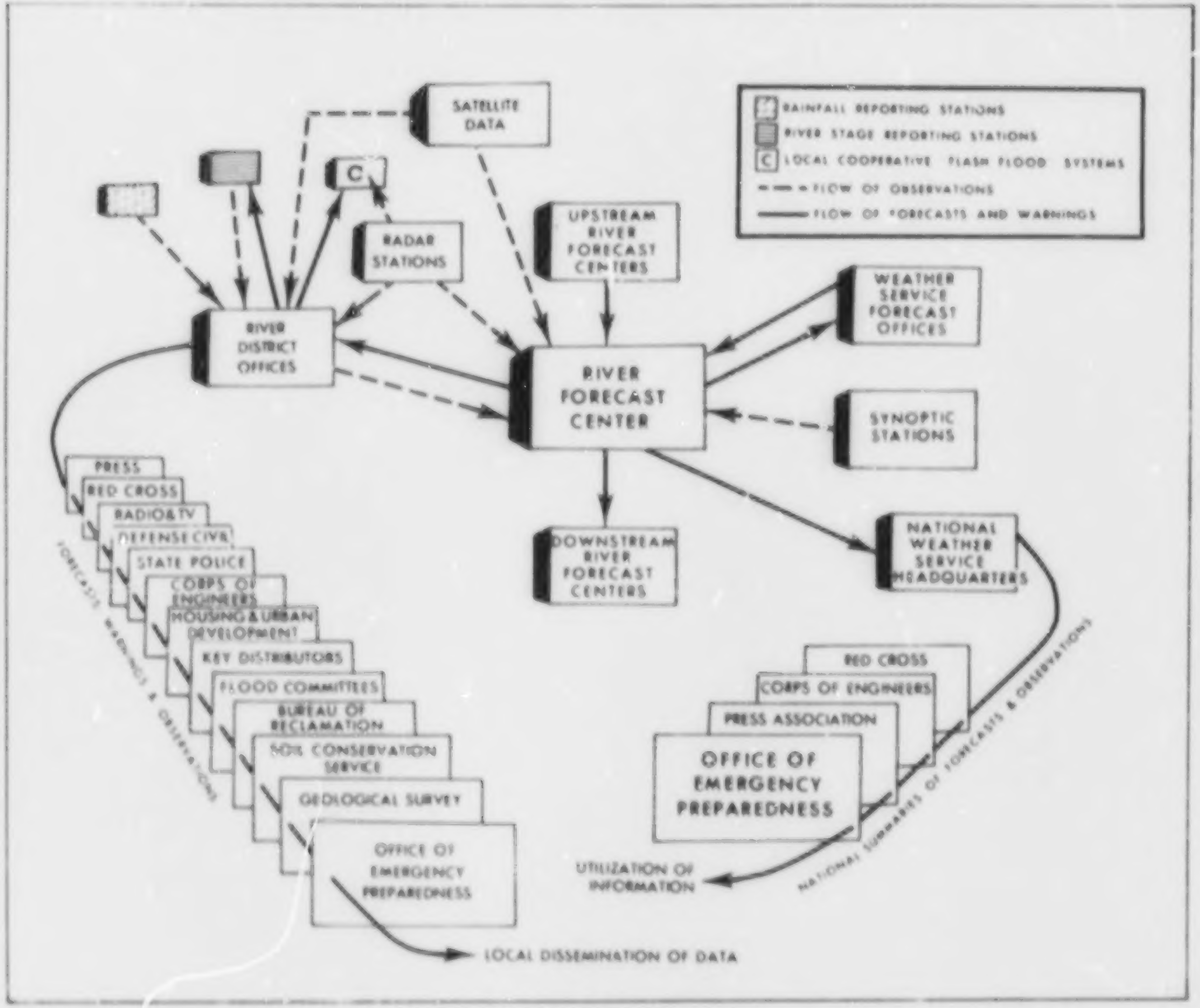
Steps have already been taken to procure and install a model WSFO facility--both hardware and software. This experimental facility will be used to validate design concepts, shakedown operational procedures, and examine the man-machine interactions in the system. Initial field implementation could take place as early as FY 1975. Five forecast offices (Pittsburgh, Philadelphia, Washington, St. Louis, and Chicago) and the National Severe Storms Forecast Center at Kansas City would be equipped with storage/display/communications devices built around mini-computers. These would be interconnected with each other and with the National Meteorological Center in Suitland via the National Digital Circuit (NDC). All data, both alpha-numeric and graphic, would be carried on the NDC. The 30 WSOs related to these six WSFOs would be equipped with Keyboard Cathode Ray Tube (KCRT) devices. The WSOs would be interconnected to each other and their "parent" WSFO. Complete implementation of the AFOS system is planned to occur in phases extending through FY 1979.

RIVER AND FLASH FLOODS

River and flash floods cause the greatest economic losses due to natural disasters in the United States, averaging near $2 billion annually, and take an annual toll of almost 100 lives. These losses can be substantially reduced by satisfying unmet needs in our prediction and warning capabilities. The Flood Warning Service is not now available to all areas. Many communities need flash flood alarm or self-help systems and more accurate forecasts of areas and amounts of precipitation are required.

Forecasts and Warnings

The NOAA National Weather Service furnishes river and flood forecast and warning services through 12 River Forecast Centers (RFC) and 71 River District Offices (RDO) to 97 percent of the United States and Alaska. In addition, RFCs and RDOs furnish some guidance to WSFOs that have primary responsibilities for the issuance of flash flood warnings.


RAINFALL REPORTING STATIONS
RIVER STAGE REPORTING STATIONS
C LOCAL COOPERATIVE FLASH FLOOD SYSTEMS
FLOW OF OBSERVATIONS
FLOW OF FORECASTS AND WARNINGS
SATELLITE DATA
C
RADAR STATIONS
RIVER DISTRICT OFFICES
UPSTREAM RIVER FORECAST CENTERS
RIVER FORECAST CENTER
WEATHER SERVICE FORECAST OFFICES
SYNOPTIC STATIONS
DOWNSTREAM RIVER FORECAST CENTERS
NATIONAL WEATHER SERVICE HEADQUARTERS
PRESS
RED CROSS
RADIO&TV
DEFENSE CIVIL
STATE POLICE
CORPS OF ENGINEERS
HOUSING & URBAN DEVELOPMENT
KEY DISTRIBUTORS
FLOOD COMMITTEES
BUREAU OF RECLAMATION
SOIL CONSERVATION SERVICE
GEOLOGICAL SURVEY
OFFICE OF EMERGENCY PREPAREDNESS
FORECASTS WARNINGS & OBSERVATIONS
LOCAL DISSEMINATION OF DATA
RED CROSS
CORPS OF ENGINEERS
PRESS ASSOCIATION
OFFICE OF EMERGENCY PREPAREDNESS
NATIONAL SUMMARIES OF FORECASTS & OBSERVATIONS
UTILIZATION OF INFORMATION

HYDROLOGIC FORECAST SYSTEM

RFCs are staffed to operate on a regular five-day week, but all are on call during weekends and at night for emergency operations during potential flood situations. The RFCs process data from rainfall stations and river gages along with other inputs from radar and satellite observations to produce river forecasts. Data are processed by computers at all RFCs except at Salt Lake City. River stage forecasts are regularly issued for approximately 2,200 points and transmitted to RDOs for expansion and clarification to make them more fully usable in their areas of river forecast responsibility.

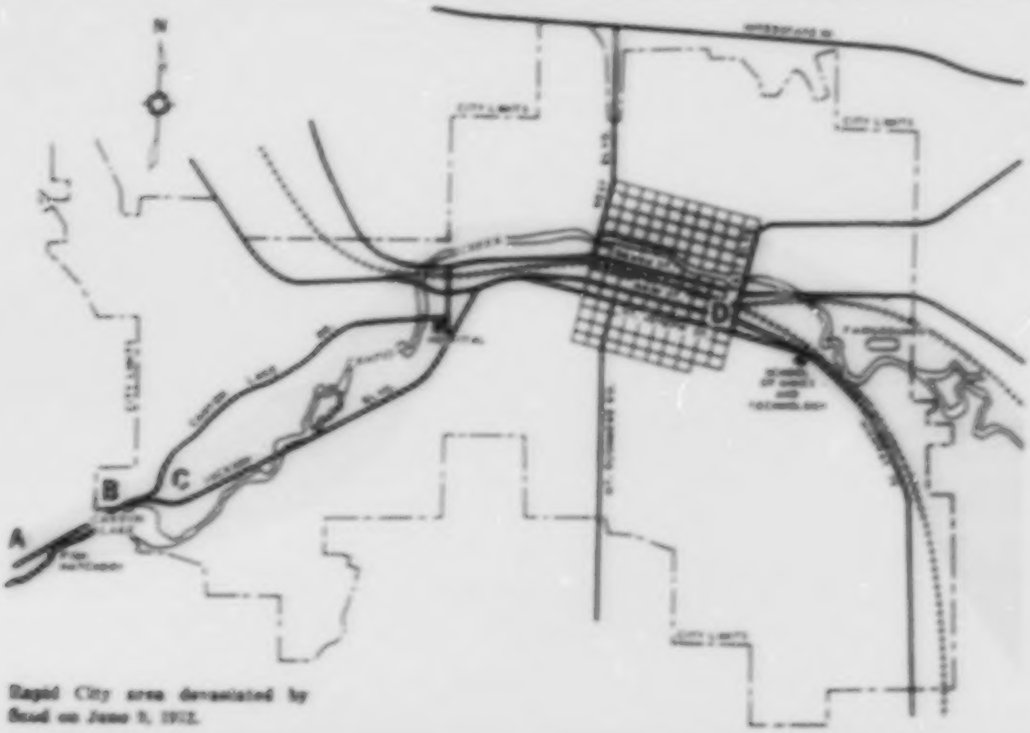
Responsibility for issuing river flood warnings is assigned to the NWS River Forecast Centers. On the basis of observed data from the hydrometeorological network and computer forecasts described above, the warning of floods can usually be issued several days in advance of the flood crest on major rivers. Flood forecast bulletins for specific stages and locations are issued when flooding is imminent or in progress. They are supplemented with specific information for local use by RDOs and distributed by the same dissemination systems discussed earlier in this plan and by special arrangement on an individual drainage area basis.

The nature of "flash floods" is implied in the name and relates to the most critical element in the warning service--time. Very heavy rainfall for relatively short periods of time over small areas causes rapid runoff of surface water which may result in highly destructive flash floods, especially in hilly areas and along the headwaters of streams. There is no time to collect and analyze rainfall and river stage data as the basis for forecasting flash floods. Since timely forecasts of their occurrence must be based on anticipated rather than observed precipitation, flash flood warning responsibility on a county basis is assigned to field offices of the NWS. Using guidance material, field offices of the NWS are responsible for issuing flash flood alerts and watches for their areas of responsibility. These alerts are for internal dissemination within NWS to alert all elements in the flood warning system to the potential for flooding and the need for all preliminary and preparatory actions by NWS offices in the event warnings may be required.

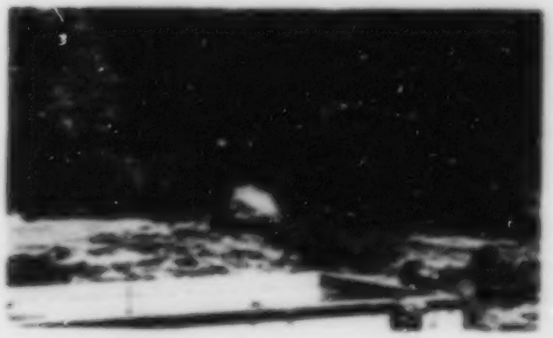
At least 2,500 communities in the U.S. are subjected to a threat of serious flash flooding. Three methods for providing adequate warnings are used. They are:

- NWS Watches and Warnings to alert potential trouble areas.
- Community self-help systems set up in cooperation with the NWS.
- Use of flash flood alarms to alert specific communities.

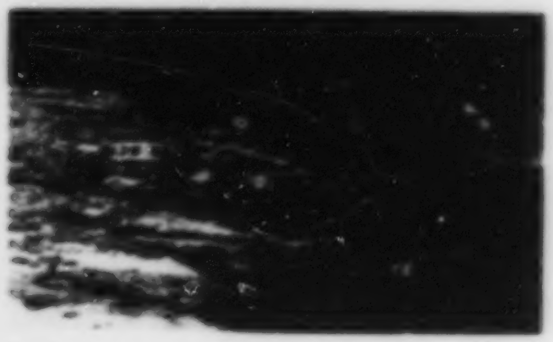
Flash Flood Watches are public notices issued by the NWS on the basis of predicted rainfall amounts for specific rivers, streams or areas indicating that hydrometeorological conditions are conducive to the development of flash flooding. Flash flood warnings are issued to the public for specific rivers, streams, or areas where flash flooding is imminent or in progress.



Rapid City area devastated by flood on June 9, 1972.



A--Southwest of Rapid City



B--Bridge washed away west of Canyon Lake

C--Canyon Lake

D--Rapid City

In implementing community self-help systems, in cooperation with the NWS, a local network of rainfall and stream-stage reporting stations is established upstream from the community. Under threatening conditions, reports from these stations are made directly to a locally appointed community flood-warning representative, who prepares a forecast using a simplified procedure provided by the NWS. The community flood-warning representative then alerts the community through a local communication system. Currently, approximately 140 of these systems are operative.

The NWS purchases, installs, and maintains flash flood alarm systems. Communities, to the extent possible, support recurring utility costs. The flash flood alarm system is designed to sound a warning to a community when river levels become critical at a predetermined upstream point. It is composed of 3 stations: a river station, an intermediate station, and an alarm station. The river station senses the critical water level and activates the alarm through the intermediate station which provides the required power and amplification to set it off. The alarm station, which is located in a fire house, police station, or any appropriate 7-day, 24-hour a day staffing unit, receives a visual and audible alarm signal indicating a potential flood disaster condition. It is then the responsibility of the community to disseminate the warning through their local communication network. Ten of these systems are planned to be in operation by mid-1973.

The warning system will be improved by extending flood forecasting services to all areas and increasing the manning of RFCs and RDOs to provide regular operations seven days a week. Computer capabilities will be made available to all RFCs and expanded to allow the use of improved hydrologic models and faster processing of data for river and flood forecasts. Flash flood specialists will be assigned in flood-prone areas to provide impetus to the community self-help programs and to install flash flood alarm systems at an increased rate. Development of the capability to collect data through the GOES satellite from automated stations to remote areas will enhance the timeliness and accuracy of forecasts and warnings.

Research

Some research is conducted within the National Oceanic and Atmospheric Administration, Department of Agriculture, United States Geological Survey and Corps of Engineers on various aspects of the river service program which relate to the flood and flash flood forecast and warning service. In addition, the National Science Foundation sponsors a number of research programs of hydrology and hydraulics that are directly applicable. An accompanying matrix shows the areas of interest and ongoing research of each agency.

	NSF	NOAA	USGS	COE	DOA
Conceptual hydrologic models for streamflow simulation	X	X	X	X	
Improved measurement of precipitation		X			X
Areal water equivalent of snow cover		X	X		X
Radar and satellite applications in operational river forecasting		X			
Snowmelt		X	X		X
Evaporation		X			X
Dynamic flood routing	X		X	X	
Ice formation and breakup forecasts		X	X	X	
Flash floods		X	X		
Improved mapping techniques			X	X	

EARTHQUAKES

Thousands of small earthquakes occur in the United States each year. Fortunately, major earthquakes are relatively infrequent. However, a severe earthquake in the vicinity of a major population center could cause loss of life and property greater than that of any other single occurrence of a natural disaster in this country. Seismically active areas of the United States are shown on a chart in the Community Preparedness (Assessment) section of the Plan.

Forecasts and Warnings

Technology has not yet developed to the point where individual damaging earthquakes can be forecast although encouraging prediction research results are being reported in Japan and the USSR. Also, there is a possibility that earthquakes can be controlled. Earthquake forecast and warning services could be useful to all segments of the population and economy. When such services are available, Federal, State, and local officials can take disaster mitigation actions such as lowering water levels behind dams, putting public utilities on alert to contend with ruptured gas and water lines, and evacuating people from particularly hazardous structures. General areas where earthquakes are most likely, the approximate timing (in terms of decades), and the approximate maximum magnitude that is possible in each area can be predicted. The most realistic opportunity for improvement appears to be in the area of probability forecasts rather than specific time and space predictions.

In recent years the occasional association of earthquake activity with reservoir impoundment and with injection of fluid in wells and large-scale fluid withdrawal has been established.

Although reservoirs have not yet caused destructive earthquakes in the U.S., some overseas areas appear to have experienced disastrous effects. In the U.S., minor earthquakes have been associated with both fluid injection and withdrawal.

Research

Basic research in tectonophysics and earthquake mechanisms including modeling of ruptures, together with expanded and automated monitoring of fault creep, earth strain, crustal movements, seismic activity, changes in the earth's magnetic and gravity fields and electrical conductivity, or other geophysical phenomena will help in the identification of reliable earthquake precursors needed for the development of forecast techniques.

The U.S. Geological Survey (USGS) of the Department of Interior is sponsoring studies in these areas to develop the physical understanding and the instrumental means required for forecasting the time, place, and magnitudes of earthquakes, and to implement and evaluate an experimental earthquake prediction system in central California. Further research is planned to evaluate results of laboratory field studies and to undertake intensive investigations of earthquake precursors by means of theoretical analyses and laboratory experiments.

The USGS is also studying the feasibility of controlling the release of stress in the upper crust of the earth. A small-scale field experiment is planned in a rock quarry where deep holes will be drilled into active fault zones to sample materials and measure rock properties.

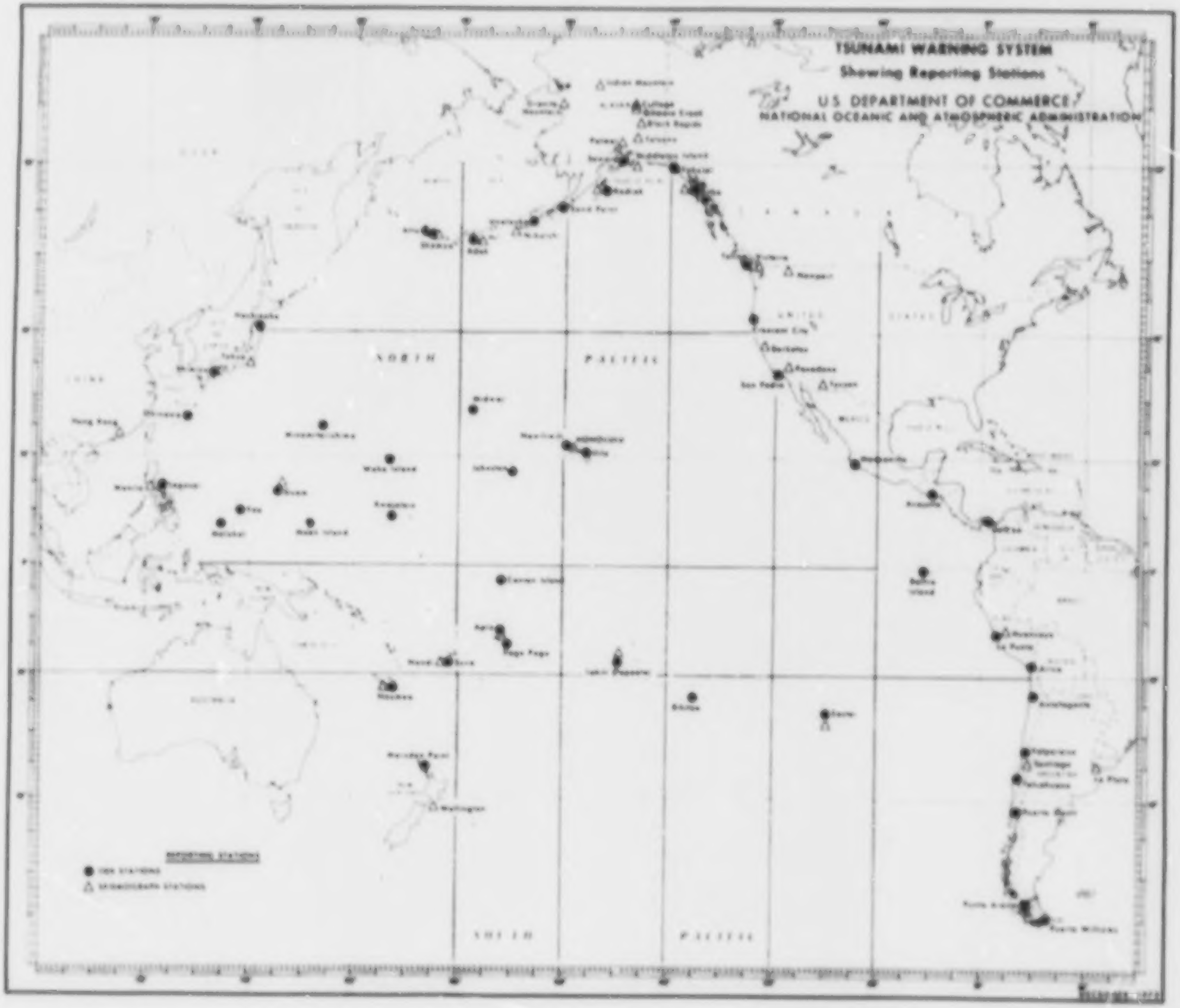
The National Science Foundation sponsors research grants for a continuing program in earthquake engineering.

TSUNAMIS

Tsunamis affect primarily the islands and coastal areas of the Pacific Ocean. The people of the Hawaiian Island have been victims of many tsunamis. Because shock waves generated by an earthquake travel through the earth much faster than a tsunami travels through the ocean, information on the location and magnitude of an earthquake can provide the basis for issuing tsunami watch and warning bulletins to the public. However, accurate prediction of a tsunami wave height at any given point on the shores of the Pacific is not feasible at present. Tsunamis travel at speeds up to 600 miles per hour in the open ocean. Therefore, the need for a rapid, reliable communications network is obvious, both for the collection and processing of data and for the dissemination of warnings.

Forecasts and Warnings

Whenever a large earthquake is recorded at seismograph stations, reports are sent via communications facilities of the Department of Defense, the Federal Aviation Administration and other agencies, both foreign and domestic, to the National Tsunami Warning Center (NTWC) located at the Honolulu Observatory where they are analyzed to determine the epicentral location and magnitude of the earthquake. When an earthquake of large magnitude occurs in a part of the Pacific that is favorable for the generation of a tsunami, the NTWC forecasts the time of arrival of the tsunami at selected points and requests data from the nearest participating tide stations that may record a wave.


TSUNAMI WARNING SYSTEM
Showing Reporting Stations
U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NORTH
PACIFIC
SOUTH
PACIFIC
CHINA
AUSTRALIA
UNITED STATES
Indian Mountain
College
Black Rapids
Palmer
Middleton Island
Kodiak
Sand Point
Newport
Crescent City
San Pedro
Pasadena
Tucson
Tokyo
Hong Kong
Midway
Wake Island
Guam
Johnston
Hilo
Canton Island
Pago Pago
Wellington
REPORTING STATIONS
● TIDE STATIONS
△ SEISMOGRAPH STATIONS

Two kinds of bulletins, watches and warnings, are issued by the NTWC. Watch Bulletins based on seismic information are issued when an earthquake of sufficient magnitude to generate a tsunami occurs under the Pacific Ocean or near its border. These bulletins normally include the epicentral location of the earthquake, its magnitude, the time of occurrence and estimated times of arrival of the anticipated sea wave at places for which the system provides warnings.

Warning bulletins are issued upon receipt by NTWC of positive evidence that a sea wave exists; such evidence is based on tide station data or other local reports. These bulletins include all information included in watch bulletins plus reported magnitude of the waves, and any other information deemed pertinent.

Watch and warning bulletins are distributed to the various governments requesting them. Warning information is currently supplied to Canada, Chile, the Fiji Islands, Hong Kong, Japan, Nauru, New Zealand, Papua and New Guinea, the Republic of the Philippines, Tahiti, Taiwan, the Territory of New Caledonia, Western Samoa, and the U.S.S.R. (through Japan). Within the U.S. bulletins are sent to civil authorities in the five Pacific states and to various civil and military organizations at the Federal level.

The speed of tsunamis is so great that the NTWC cannot effectively warn areas very near earthquake epicenters. Regional Warning Centers have been established for this purpose in Japan, U.S.S.R. and Alaska and a regional center is planned for collocation with the NTWC in Hawaii.

In the regional warning systems, the initial watch or warning bulletin is issued by the regional seismological center, generally on the basis of seismic data only. Subsequent watch and warning bulletins may be issued either through the NTWC at Honolulu or through regional tsunami warning centers.

To provide necessary data for the Alaskan Regional Tsunami Warning System, data are telemetered to Palmer, the operational center, from 13 seismic stations and 8 tide stations.

Currently, the supporting data system for the forecast and warning system includes 23 seismograph observatories and 48 tide stations in 17 countries and territories throughout the Pacific as shown on the accompanying chart. In the planned system additional participating seismograph stations will be added to support tsunami warning services in Central and South America, Kamchatka, New Guinea, and the Bonin Islands. Additional tide stations will be sought throughout the Pacific, particularly on the west coast of the U.S. and in Alaska, Mexico, Peru, Chile, and the U.S.S.R.

The most promising area for improvement of warning services lies in the reduction of the time lag between the occurrence of the seismic event and the issuance of tsunami watch and warning bulletins. In the planned system, data collection and warning delays will be reduced by the real-time telemetry of seismic and tidal data. Extensive use of the GOES satellite is planned as a communications relay for the real-time readout of data stored in a memory bank at each seismograph station in the system. A computer will process incoming data to give a hypocentral location (includes both epicenter location and depth) and estimated times of arrival of the potential tsunami and also prepare required watch bulletins for release by the personnel at the tsunami warning center. Appropriate tide stations will also be interrogated on a real-time basis so that warnings can be released more rapidly to the dissemination agencies in the system and to the general public.

Research

Improvements in tsunami prediction techniques and warnings depend on further understanding the generation, propagation, and onshore run-up mechanisms of tsunamis. Basic research in tsunamis is conducted in many universities and by government agencies. Basic and applied research is carried out at the University of Hawaii by the Joint Tsunami Research Effort (JTRE), which is a University of Hawaii/NOAA cooperative group.

It has long been recognized that one of the major gaps in conducting research either on run-up or on source mechanisms is the lack of tsunami measurements in the open ocean. The JTRE is developing a tsunami wave-height recording system. Until such time as open ocean wave heights are available to the warning center in real-time, it is doubtful that objective forecasts of nearshore wave heights can be made. Open-ocean wave measurement devices that rest on the ocean bottom and transmit pressure variations associated with wave heights have been developed. Also, the design is completed and components are being tested of a permanent tsunami measuring system that could be deployed on the ocean bottom in the vicinity of a ship. An ocean-bottom tide recorder will be implemented to close the gaps in the existing data-gathering network and also to provide essential data needed for basic research in tsunami height forecasting.

Run-up studies continue to receive a large amount of attention. Some theoretical work is being done on the response of harbors to long period waves. The U.S. Geological Survey is working on studies of tsunami run-up and inundation in San Francisco Bay. The Corps of Engineers is active in research on tsunamis in bays and on possible protective barriers.

The National Science Foundation supports several research programs directed at tsunami generation, propagation, detection and run-up. Of particular interest is the development of an instrument to detect the occurrence of tsunamis by coupling seismic measurements with radar sensing of atmospheric waves travelling in the vicinity of the tropopause, that are hypothesized as being initiated by an earthquake.

EXTREME FIRE WEATHER

The forest areas of the United States produced $1 1/4 billion of timber from state and private lands in 1970, while Federal forests yielded $500 million from timber sales, royalties and grazing rights in the same year. These same resources, however, are seriously endangered every year by man-made and natural forest fires. During the decade of 1960-69, an average of 4.8 million acres was destroyed by fire each year.

Unmet needs include the completion of development and nationwide implementation by the Forest Service of the Department of Agriculture of an objective fire-danger risk rating system, and analysis of the need for expansion by NOAA of the fire weather service to forest and rangeland fire control agencies.

As an integral part of its fire protection program for the Nation's forests, grasslands and wild areas, the Forest Service is developing a national fire-danger rating system (NFDRS) which is partially implemented and will be implemented nationwide by the end of calendar year 1974. Fire danger is defined in terms of an index based on factors related to the likelihood of the occurrence of a wildfire and its probably severity, expressed in terms of the anticipated level of difficulty to control.

Fire occurrence probability and fire intensity are dependent upon ignition sources, fuel characteristics, topography, and past, present, and future weather conditions. Of these factors, only weather and ignition sources change rapidly.

Forecasts and Warnings

NOAA's National Weather Service (NWS) issues daily 24-hour forecasts of fire weather conditions, and Fire Control Offices issue daily fire-danger statements. The fire danger statements and the fire weather forecasts and warnings are issued more frequently during periods with critical fire danger. Both the fire-danger specification and weather prediction provide the basis on which specific fire protection decisions and actions are programmed and executed. Extreme fire danger or emergency conditions are those which have been exceeded less than 5 percent of the time in all past records.

Each fire protection area generally has a manning and action plan which is tied to fire danger conditions. These plans specify the allocation of fire suppression resources and crews and other actions such as alerting or warning the public against specific activities.

The forest fire protection programs of state forestry agencies are coordinated by the Cooperative Forest Fire Control Program of the Forest Service. In the eastern and southern states, the state fire protection organizations are grouped into fire protection compacts (New England, mid-Atlantic, Southeastern and Gulf Compacts). These compacts insure that each state discharges commitments to specific regional aid actions in high-emergency situations or under conditions of extreme fire danger.

Raging forest fire started by lightning (U.S. Forest Service Photo).

Wildfire aftermath.

In the western and central United States, fire protection plans of the states are tied to those of the Forest Service or the Bureau of Land Management under which mutual aid in extreme or emergency conditions is also pledged.

In the operation of the Fire Weather Service weather forecasts and warnings especially designed for fire control agencies, both Federal and state, are issued by Fire Weather Offices of the NWS throughout the United States. Fire Weather Service is provided to user groups in forest and range areas from Primary and from Supplementary Fire Weather Offices. Primary Fire Weather Offices are usually located in or near major forested areas where they can best meet the needs of user agencies; these offices are staffed with one or more specially trained fire weather meteorologist. Supplementary Fire Weather Offices provide fire weather service in addition to their primary public service function. Usually they provide fire weather forecasts only on request or when fire danger is high. During the fire weather season meteorologists at these offices are responsible for the issuance of fire weather forecasts for their designated areas of responsibility. During critical fire-danger periods, forecasts are issued as frequently as necessary to apprize fire control officials of changing weather conditions that may affect the ignition, intensity, and spread of wildfires. During periods when fire danger is low, the number and timing of fire weather forecasts varies with the needs of local users, but are generally issued once or twice daily in support of users' operations and planning. In the western United States fire weather offices are equipped with mobile units so that during conflagrations the fire weather meteorologists can provide on-site weather observations and forecasts to fire control officials. Additional details are provided in the current version of the Federal Plan for a National Fire Weather Service which will be revised soon.

Weather measurements are required in support of fire-danger statements and weather forecasts at least once each day during the fire season. The network density required depends on both the spatial variability of various factors affecting fire danger and the degree of accuracy required in describing the level of fire danger. The density requirement far exceeds that which is available in the regular reporting networks of the NWS. Consequently, the Forest Service and other fire protection agencies operate supplementary weather reporting networks. This type of network consists of at least one fire weather station for each fire-danger zone, an area varying in size from a few hundred to a few thousand square miles. The Forest Service alone operates about 1,100 fire weather stations. State forestry agencies and other Federal land management groups also operate similar networks.

There appears to be an increasing demand for Fire Weather Services in areas not currently covered. NOAA will analyze this demand to determine if the program should be expanded into the remaining forest and grassland areas of the conterminous United States, Hawaii, and Alaska.

The ability to provide accurate and meaningful forecasts and advisories for fire control areas depends on the availability of weather observations from sites which are truly representative of conditions in those areas. Special fire weather observing stations augment the existing meteorological and forestry networks. The future number of reporting stations required will be a function of area, size, topography and vegetation.

Research

In support of fire-danger warning statements and weather predictions, the NWS, in cooperation with the Forest Service and specifically with the latter's Ft. Collins, Colorado, research station, will concentrate research and development in the following areas: development of a lightning prediction numerical model; development of a topographically disturbed surface windflow model; and improved observing and forecasting techniques for weather modification activities to suppress wildfires. The latter must include the detection of incipient cumulus convection and its movement. Continuing efforts will be made to develop numerically produced meteorological inputs to the NFDRS in order to extend to at least five days the Fire Danger predictions of three indices: the Occurrence Index which is related to the potential fire incidence within a rating area; the Burning Index, related to the potential amount of effort needed to contain a fire in a particular fuel type within a rating area; and the Fire Load Index, related to the total amount of effort required to contain all probable fires occurring within a rating area during a specified period.

The National Environmental Satellite Service is planning research in detection of fire danger based on radiation patterns from various types and conditions of vegetation.

DROUGHTS

Drought conditions may be due to inadequate natural water supply, improper use of available water resources, or inadequate water storage and delivery systems. A serious economic impact can develop over a prolonged period in a drought stricken area. Drought is the largest single cause of all crop losses in the United States accounting for 40% of all indemnities paid by the Crop Insurance Corporation.

Two major drought-related assessment programs are conducted by Federal agencies.

The water resources investigations program of the U.S. Geological Survey (USGS) deals with both surface and sub-surface water supply and with extent of utilization. A basic objective is to distinguish the causes of inadequate supplies and to suggest possible remedies.

The NOAA Environmental Data Service Drought Index program is designed to assess the current extent and severity of drought and to aid the government in decisions concerning designation and alleviation of disaster conditions in drought areas. The drought conditions addressed in this program are those that develop gradually over an extended period of below normal rainfall and tend to persist until rainfall has become normal or above normal for a period of time. Except for this persistence which is based on an accumulated deficiency of rainfall that requires some time to overcome, forecasts of the onset or end of drought cannot be made with any appreciable accuracy.

Water Resource Assessment

With respect to the water resource assessment program of the USGS, local decisions on the development and utilization of water supplies should be based on full assessment of the characteristics and availability of water resources. The local community should have and use adequate information on surface water and ground water resources, analyzed and presented so planners and developers can make decisions on the basis of whatever conditions exist and avoid waste, for example, through contamination and misuse. A proper assessment of total available water resources makes it possible to maintain a balance between water development and the planned industrial, agricultural and municipal uses, thereby minimizing the likelihood of inadequate water supply and possibly providing reserves to meet needs imposed by periods of insufficient precipitation.

Information on streamflow and ground water conditions is distributed monthly as part of the overall water resources program of the USGS. Areas affected by deficiencies are observed and reported on more frequently when droughts appear imminent.

Ground water resource assessments are planned in 21 river basins of the United States. Three basin studies have been completed, two are underway, and the remainder are planned for completion by the end of FY 1975. Development work in support of water resource assessment includes: work on improved sensors, and supporting communication systems to aid in monitoring and assessment of water systems; study and testing of improved hydrologic models; and the use of aircraft and satellites for surveying, monitoring, and communication with remote instrument stations.

Drought Assessment

When drought develops, its severity is assessed on the basis of rainfall and temperatures and their departures from values which would have been climatically appropriate at the time and place being analyzed. NOAA's Drought Index, which is based on these factors, is used to express the drought severity.

Offices of the NWS initiate the preparation of drought indices by collecting, by mail and telephone, temperature and precipitation records from cooperative networks. Area averages are computed and either phoned or sent by teletypewriter to NOAA's National Climatic Center or to NOAA's Laboratory for Environmental Data Research where the weekly data are tabulated and mapped. An attempt is underway to speed the issuance of weekly charts by reducing the present 4-day data collection lag to two days by the use of telephones instead of mail.

Drought Index is computed for a monthly period at the National Climatic Center and issued weekly for the preceding thirty days from May through October (growing season). The index values are plotted and analyzed on a chart of the conterminous United States. They are distributed over the NWS facsimile circuits and sent to the Office of Emergency Preparedness and to the Office of the Secretary of Agriculture.

During the growing season, another drought indicator is also used. This is Palmer's Crop Moisture Index, which is published in the form of a weekly chart based on weekly areal mean values of temperature and precipitation for 350 climatological divisions. The Crop Moisture Index, however, is more of an agricultural tool and is more sensitive to weekly precipitation variations than the Drought Index. It is concerned with water available for growing rather than with the general water supply. The Crop Moisture Index Chart is published in the Weekly Weather and Crop Bulletin, which, through successive distribution facilities, reaches thousands of users.

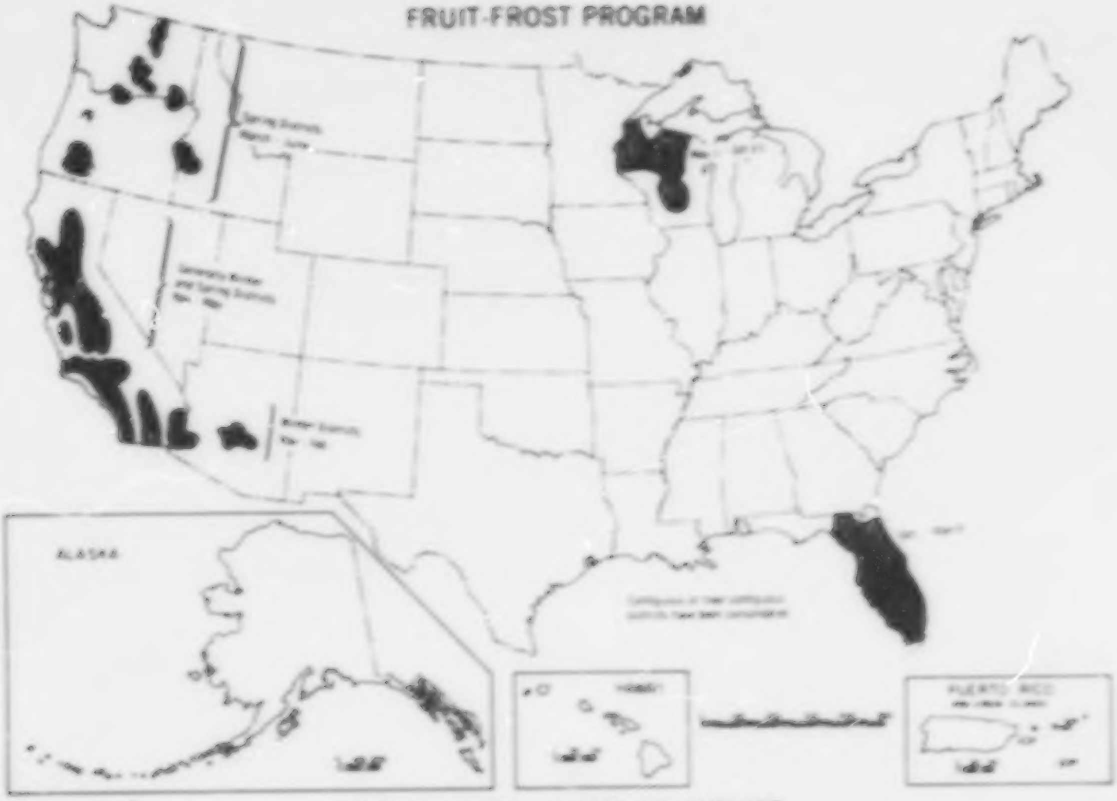
The use of the Drought Index and the Crop Moisture Index will be continued. The development of these indices has been achieved relatively recently and no changes are planned at this time. It is also planned to publish historical values of drought indices so comparisons can be made with previous record droughts and water supply systems can be planned in accord with the design statistics developed.

FROSTS AND FREEZES

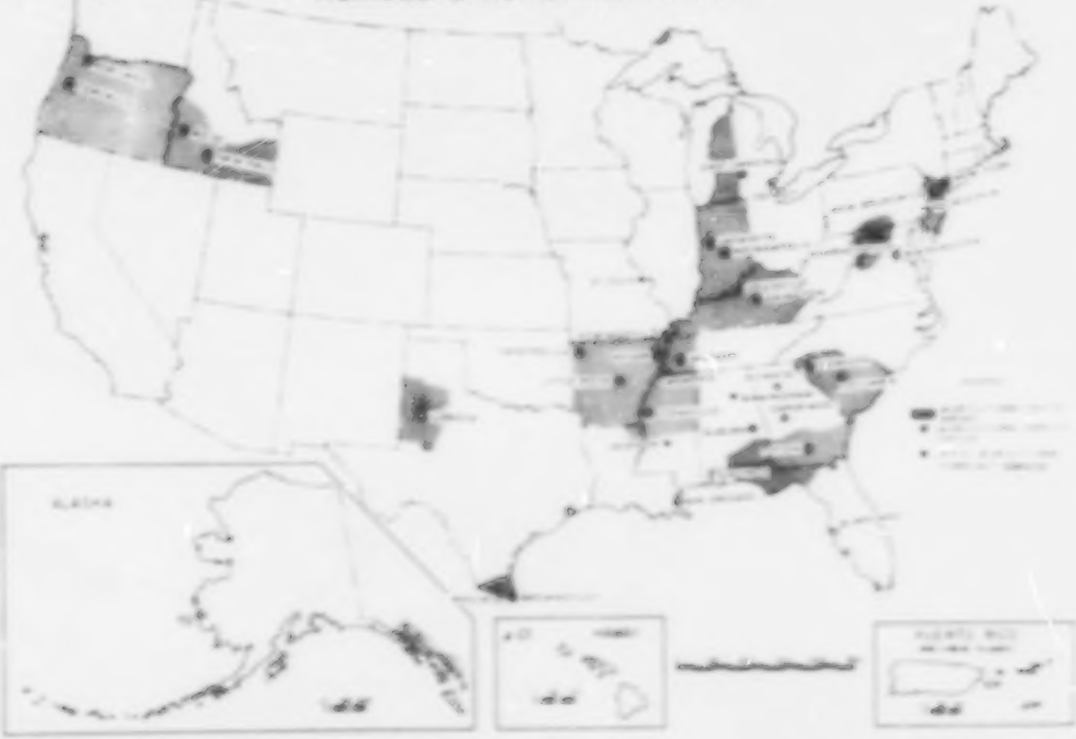
Agricultural losses due to frosts and freezes average more than $1 billion annually. Other industries are affected to a lesser degree but are not included in this Plan. Completion of implementation of the Federal Plan for a National Agricultural Weather Service is needed to extend more effective frost and freeze protection information to all areas of the United States.

Agricultural frost and freeze services are provided by the NOAA National Weather Service through two types of specialized operational programs, the Fruit-Frost Weather Service and the Agricultural Weather Service. These programs vary more in the degree of detail and of emphasis than in actual type of service products. The areas now being served by the Fruit-Frost Service and by the specialized Agricultural Weather Service are shown on accompanying charts.

FRUIT-FROST PROGRAM


Spring Districts
March - June
Combined Winter and Spring Districts
Winter Districts
ALASKA
HAWAII
PUERTO RICO

AGRICULTURAL WEATHER SERVICE


ALASKA
HAWAII
PUERTO RICO

Forecasts and Warnings

In the Fruit-Frost Service detailed temperature forecasts and warnings are given for many key stations in local areas where the primary concern is the issuance of forecasts, warnings, and advisories of low temperatures and their effects on ornamentals, plants, deciduous fruits, and citrus fruits. In these areas detailed minimum temperature forecasts and warnings of frost and freezing temperatures are issued for the next two nights for specific temperature stations.

In the Agricultural Weather Service parameters other than low temperatures are frequently of more interest and concern, and more general forecasts and warnings including frost and freeze warnings are provided for broader areas, e.g., counties or groups of counties. However, forecasts of low temperature conditions are given top priority during those periods when low temperature may adversely affect growth, maturation, harvest, storage and shipment of agricultural products.

In both types of programs weather forecasts of clouds, winds, and precipitation and an outlook for the next three to five days are included. In the supporting detection system conventional surface and upper air observations are supplemented with additional reports, especially of temperature, dew point, precipitation and wind, and at critical times such as early spring, by soil temperatures.

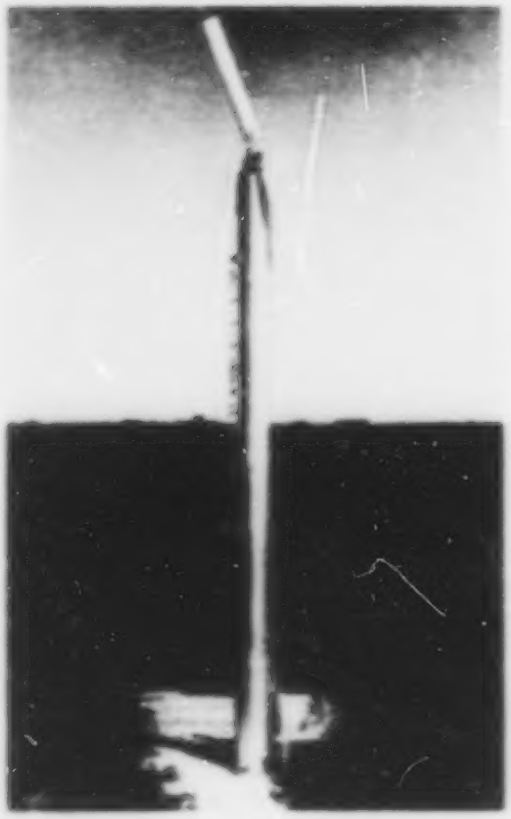
Additional services supplement the weather forecast and warning services. Advisory service is provided to growers on how to solve their problems in the prevention of damage from frost and freezing temperatures through the use of orchard heating devices, air circulation machines, and water sprays and through the use of temperature surveys to provide information on local areas where lower minimum temperatures occur frequently. Studies are conducted at NWS Agricultural Service Offices on temperature and crop relationships.

As in the case of the Fire Weather Services, the expansion of Agricultural Weather Services is dependent on an assessment of the intensity of demand in areas not presently being served. The criticality of demand must be weighed against other high-priority programs. Continued assessment of the demand for agricultural weather services and supporting dissemination systems will do much to assure adequate freeze and frost service in areas of highest priority.

Research

Supporting research concerned with the effects of weather on growth, reproduction and yield of plants and animals is being conducted as cooperative projects by agricultural experiment stations and the National Weather Service.

Oil-fired heaters protecting a citrus grove against frost damage.



Wind machine used to reduce radiational cooling.

VOLCANOES

Federal programs are undertaken to minimize the damages caused by volcanoes by delineating the hazardous areas, controlling the uses of land in such areas, and learning to predict eruptions so the areas can be evacuated.

Forecasts and Warnings

Constant observation and research at the Hawaiian Volcano Observatory permits the issuance of warnings of impending eruptions. Occasional short-term observations of the volcanoes of the Pacific Northwest verify their continued low level of activity.

The USGS staff at the Hawaiian Volcano Observatory monitors the active volcanoes Kilauea and Mauna Loa. The volcanically-generated microearthquakes, ground swelling and tilting, temperature variations, and the type and amount of material discharged from the vents indicate the level and type of activity. Upon signs of unusual activity, integrated systems of instruments are deployed to determine the pattern of activity and changes in rates. Unusual distortions and accelerations provide an indication of an impending eruption and early warnings are issued.

Infrared sensing of the inactive volcanoes of the Pacific Northwest detects changes in distribution and intensity of "hot spots"; monitoring of the microearthquake activity for brief periods at Mt. Ranier, Mt. Saint Helens, and Lassen Peak shows a continuing low level of activity. Suspicious signs of thermal activity, most readily detected by infrared sensors, would be further investigated by ground surveys using seismic and deformation monitoring equipment.

In the planned system, surveillance of the inactive volcanoes of the Pacific Northwest will be regularized, and the capability to provide intermittent instrumental monitoring will be extended to the existing 12 volcanoes. Surveillance and interrogation of automatic instruments by regular aircraft and satellite flights are feasible.

Research

Scientific investigations of representative types of volcanoes are yielding fundamental understanding of the many different phenomena associated with different kinds of volcanoes. The study of the Jemez Mountains, a large inactive volcano complex in New Mexico, has produced information on structure and volcanic products that has contributed to the understanding of large-scale eruptions. Improved models for prediction and interpretation are being developed from the research program.

LANDSLIDES AND AVALANCHES

Federal programs dealing with the hazards of landslides and avalanches are directed toward the preparation of landslide risk maps for all areas of the U.S. where high susceptibility to this hazard imperils concentrations of people and important structures, and toward the conduct of field and laboratory research on the causes and mechanics of landslides so as to develop the capability to predict the time and extent of landsliding and avalanches of snow and ice.

Landslide Forecasts and Warnings

Forecasts and warnings of landslides are not feasible. However, their impact on life and property can be mitigated by risk assessment programs which are discussed later.

Avalanche Forecasts and Warnings

The Forest Service of the Department of Agriculture now evaluates the snow avalanche hazard at specific heavy-use areas such as ski operations in the western U.S. Also, close cooperation is maintained with state highway departments, mining companies, and with several university snow research programs to predict avalanche hazard at specific mine sites, railroads, and highways. No general predictions are made for back-country or other less used areas.

Experienced observers have developed sufficient skill to evaluate subjectively the hazard of snow avalanches in their immediate areas. General knowledge of weather conditions, recent and predicted snowfall, and observation of naturally occurring avalanches lead to subjective predictions and consequent control action. Data on weather and snowpack condition (depth, density, strength) are gathered in many areas, but are used mostly to supplement subjective field observations and to focus attention on likely trouble spots.

Under extreme conditions, general warnings of possible avalanche activity are issued through the National Weather Service facilities for broader areas. National Forests and universities cooperate in this warning situation primarily in the States of Colorado and Washington with other states involved from time to time.

The Forest Service is now collecting weather, snow, and avalanche data at 42 locations in 12 western states as a step in the development of an "avalanche hazard rating index." The data network represents a wide variety of conditions across 25 degrees of latitude and elevations up to 11,300 feet in Colorado.

Plans are to continue with the development of the avalanche hazard rating index to provide a quantitative evaluation of avalanche hazard. Preliminary simplified models are ready for testing in some areas. Eventually, an avalanche hazard rating index could be used with a mountain weather forecast to provide an avalanche warning service for the western United States.

C. WARNING DISSEMINATION

Effective dissemination is a vital part of the warning system. For maximum use, warnings must reach all affected members of the public and responsible officials with minimum delay and must convey maximum understanding. This is necessary to allow adequate lead time for making decisions and for taking protective actions to mitigate the effects of the disaster. Dissemination as discussed in this Plan includes communication systems used for the reliable exchange of information among the warning offices.

Radio, television, telephone and teletypewriter systems that are currently available for dissemination of natural disaster warnings were all designed to serve multi-mission roles. Each routinely provides general weather information and forecasts to special user groups in addition to disseminating warnings. None of these systems is complete. Since each primarily serves a different group, they need to be expanded and all must be used to insure maximum warning coverage until a unique warning dissemination system is fully implemented and proven. Such a system with a 24-hour alerting capability could satisfy requirements for some of the multiple systems now used. Increased use of National Warning System (NAWAS) circuits and public law enforcement networks is needed for interstate and intrastate coordination of warnings and for greater feedback on the adequacy of warnings during rapidly changing situations.

In 1971 the Administration completed a review of national policies and programs for use of telecommunications to provide the American public with warnings of an enemy attack or of potential natural disasters. Emphasis was placed on systems capable of being extended directly into the home and operating 24 hours per day. A basic national policy adopted is that the acquisition and use of a warning receiver by any citizen shall be a voluntary decision on the part of the individual.

It was concluded that the Decision Information Distribution System (DIDS), an on-going program of the Defense Civil Preparedness Agency (DCPA), appears capable of meeting the requirements for a natural disaster warning dissemination system in terms of coverage, geographical selectivity and rapid response time. This system is being developed, and limited area testing will start in the spring of 1973. Meanwhile, NOAA in conjunction with NASA has studied the feasibility of a Disaster Warning Satellite System (DWSS) for both the dissemination of natural disaster warnings and the collection of data and feedback information before and during natural disasters.

Because many citizens may not acquire a DIDS warning receiver, the use of the dissemination systems listed in the accompanying chart will continue to be required for effective warning dissemination. The chart summarizes the types of warning information transmitted via the various systems.

A brief discussion summarizing the applications of systems listed on the chart follows. A more complete description of each system is given under each major subdivision of systems.

SYSTEMS USED FOR WARNING DISSEMINATION SYSTEM	Operating Agency	Hurricane & Storm Surge	Tornadoes & Severe Local Storms	Severe Winter Weather	River Floods	Tsunamis	Fire Weather	Frosts & Freezes
Office to Office Communications System								
Radar Reporting & Warning Coordination (RAWARC) Teletypewriter Network	NOAA/NWS	x	x	x	x			x
Service A (Nationwide Aviation weather, teletypewriter system)	FAA	x	x1/					
Service C (Nationwide general weather teletypewriter system)	FAA	x5/	x1/	x	x			x
Service O (Nationwide weather teletypewriter circuit carrying international reports)	2/ FAA	x						
NOAA Weather Wire Service (National teletypewriter network)	NOAA/NWS	x	x	x	x		x3/	x4/
The National Warning System (NAWAS) (National telephone network)	DCPA	x	x	x	x	x		
Public Contact Systems: (Local Community)								
VHF-FM Radio Continuous Weather Transmissions	NOAA/NWS	x	x	x	x	x		x
Multiple Access Recorded Telephone Announcement Systems	NOAA/NWS	x	x	x	x			x
Mass Media (Radio, TV, Newspapers, Press Wire Service)	Commercial Interests	x	x	x	x	x		x
Sirens	DCPA		x					
Decision Information Distribution System (DIDS) (prototype under development)	DCPA	(System will be tested soon)						
Disaster Warning Satellite System	NASA/NOAA	(Being studied)						

1/ Tornado and severe local storm watches, are included in state forecasts when appropriate.
2/ Operated through NOAA/NWS computer in Washington.
3/ Supplemented by direct telephone, radio and telegraph messages to fire control organizations.
4/ Supplemented by code-a-phone (remotely recorded telephone) announcements and local direct broadcasts.
5/ Unscheduled.

The primary means for disseminating natural disaster warning information to the news media is the NOAA Weather Wire Service (NWWS), a teletypewriter network. The news media perform a valuable public service by disseminating forecast and warning information as news. Dissemination directly to the public is accomplished using multiple access recorded telephone announcement systems and VHF-FM radio continuous weather transmissions. The National Warning System (NAWAS) is used to reach public officials.

Warning information and radar reports are exchanged among warning offices via the Radar Reporting and Warning Coordination (RAWARC) teletypewriter network. The National Warning System (NAWAS), a telephone party-line network, can also be used for exchanging warning information.

Services A, C, and O are the teletypewriter networks that collect and distribute basic forecast and warning information and meteorological data to weather offices.

These basic systems are supplemented as required for dissemination to special user groups. Fire-weather warnings are disseminated to fire-control organizations via special fire-weather teletypewriter circuits; also direct telephone, radio, and telegraph messages are used to reach fire-control offices in some remote areas. Frost and freeze warnings are disseminated to fruit and vegetable growers and to transportation and marketing groups by direct local broadcasts, teletypewriter, and by code-a-phone (remotely recorded telephone) announcements. At U.S. installations in the Pacific area tsunami watch and warning information is distributed primarily through facilities of the International Civil Aviation Organization and the Department of Defense, e.g. the Aeronautical Fixed Telecommunications Network and the Automatic Digital Network (AUTODIN); in Alaska the NOAA marine radio system is used to supplement NAWAS which does not cover the entire state. Police circuits and Red Cross communications facilities are used to assist in the further dissemination of natural disaster warning information received over NAWAS.

OFFICE TO OFFICE COMMUNICATIONS SYSTEMS

Radar Report and Warning Coordination Network

The RAWARC system is operated to collect, coordinate, and distribute radar reports and environmental warning information among weather offices. It provides rapid relay to other circuits and contributes to the coordination of warnings in adjacent states. RAWARC consists of five teletypewriter circuits which terminate at Kansas City, Missouri and Suitland, Maryland. Kansas City is the monitoring station and Suitland is responsible for RAWARC intercircuit relays. During the hurricane season, a few stations not normally on RAWARC are also added. The traffic on RAWARC is basically unscheduled and is handled according to a priority system. The only regularly scheduled operation on RAWARC is an hourly collection of radar reports which are relayed to other communications systems as required. Automation and extension of RAWARC to 31 additional locations is planned in Fiscal Year 1974, which will complete the network.

Service A

Service A is a nationwide aviation weather teletypewriter system managed by the Federal Aviation Administration (FAA). It is computer operated and designed to serve aviation needs by carrying hourly aviation weather reports, aviation weather forecasts and warnings, and notices to the NWS, the FAA, the military, and mass transportation air carriers.

Service C

Service C is a nationwide weather teletypewriter system which carrys surface and upper-air data; public, marine and other forecasts and some warnings; river data; and special guidance material for professional meteorologists. It is managed by the FAA. Most of the data and information are supplied by the NWS.

Service O

Service O is a nationwide weather teletypewriter network which is used for the international exchange of surface and upper-air data; aviation terminal forecasts; analyses and prognoses; and marine reports and forecasts. It is leased by the FAA and operated through the Washington National Meteorological Center (NMC) computer by the NWS.

NOAA WEATHER WIRE SERVICE

The primary purpose of the NWWS is to distribute consumer-oriented weather warnings, forecasts and other important environmental data to mass news disseminators for relay to the public and various specialized users, usually on an intrastate basis. Interstate relays are made via an overlay circuit.

The NWWS is now established in a number of states as shown in the accompanying chart. By the end of Fiscal Year 1973, the NWWS will have been implemented either completely or partially in 30 states. Only offices of the NWS, or certain other authorized offices on a very limited scale, have direct entry rights on these circuits. The information is relayed between circuits as required. Local public service teletypewriter circuits are operated by the NWS in the cities identified on the accompanying chart. These local circuits serve 241 radio or TV outlets, primarily in states where the NWWS is not yet available.

Plans to expand the NWWS to all of the conterminous states by the end of Fiscal Year 1978 are based on the assumption that NWWS continues to enjoy its current relative priority within available funding.

NOAA WEATHER WIRE SERVICES

LOCAL PUBLIC SERVICE COMMUNICATIONS FACILITIES

NATIONAL WARNING SYSTEM

The NAWAS is designed to provide notification of an actual attack upon the United States to Federal agencies, the military, State governments, counties and cities. Under the Disaster Relief Act of 1970, the use of the NAWAS is authorized also for the purpose of providing warnings to local officials in areas endangered by imminent natural disasters. As it is a two-way voice party-line communications system, the use of the NAWAS additionally for the communication of any critical information during emergencies is actively encouraged.

Policies and procedures for the NAWAS are established by the DCPA. The system is funded by the U.S. Army Strategic Communications Command (USASTRATCOM) which also provides personnel to operate the NAWAS for DCPA.

Three DCPA National Warning Centers located in protected facilities control NAWAS. These Warning Centers are designated as National One, National Two and National Three. NAWAS consists of two separate circuits, the control circuit and the national warning circuit for DCPA to use in disseminating the attack warning. The national warning circuit may be subdivided electronically into eight area circuits. Each of the eight DCPA Regions control an area circuit comprising all the warning points (e.g. State Police Headquarters, and selected NWS Offices) within the geographic boundaries of that Region. Within each State, one warning point is designated as the State Warning Point.

National One Warning Center (or either National Two or Three when acting for National One) can seize the entire system at any time and operate it as a single entity. Within each State, the warning circuit can be disconnected to become a State warning circuit controlled by the State Warning Point which is controlled by ranking State authorities. The State Warning Point under this condition monitors both the State Warning Circuit and the National or Regional Warning Circuit and the two circuits can be immediately reconnected.

NAWAS operates 24 hours daily and terminates at 1,867 warning points throughout the United States. Approximately 1,250 of these are located at offices of the state police, municipal police and fire stations. Forty two installations are located at U.S. Coast Guard facilities for alerting ships at sea. Approximately 230 are located at NWS offices.

Most warning points (approximately 90%) are provided with emergency power for operation of the warning equipment, and the remaining warning points are programmed to receive it.

By joint agreement between DCPA and NWS the use of NAWAS has been expanded to include the dissemination of warnings and other information related to natural disasters. NWS offices with warning responsibilities now have terminals on state NAWAS with standard warning point equipment. When used for natural disaster warnings, the circuit is usually on the "State circuit" configuration so that each warning point transmission is heard simultaneously by all other state terminals. This party-line aspect of NAWAS provides an excellent method for collection of feedback information by NWS offices when storm reports are made to various control points. Use of the system for this purpose is being given special attention by both DCPA and NWS because such feedback is difficult to obtain by any other means. In addition, the NWS operates 43 interstate terminals for warning dissemination in adjacent states.

In some communities outdoor sirens may be activated directly from the location where the warning is received. Similarly, warning points located at State Police Headquarters normally use State Police radio and/or teletypewriter networks which provide a rapid means of dissemination throughout the State to local governments.

Expanded uses of NAWAS now planned include: installation in one NWS office in each state of a drop on the NAWAS circuit in an adjoining state; and use of NAWAS for intra-NWS coordination of disaster information.

In summary, NAWAS is composed of individual circuits in each state and various other circuit configurations permit the tying-in of the different states and regional areas when appropriate.

PUBLIC CONTACT SYSTEMS

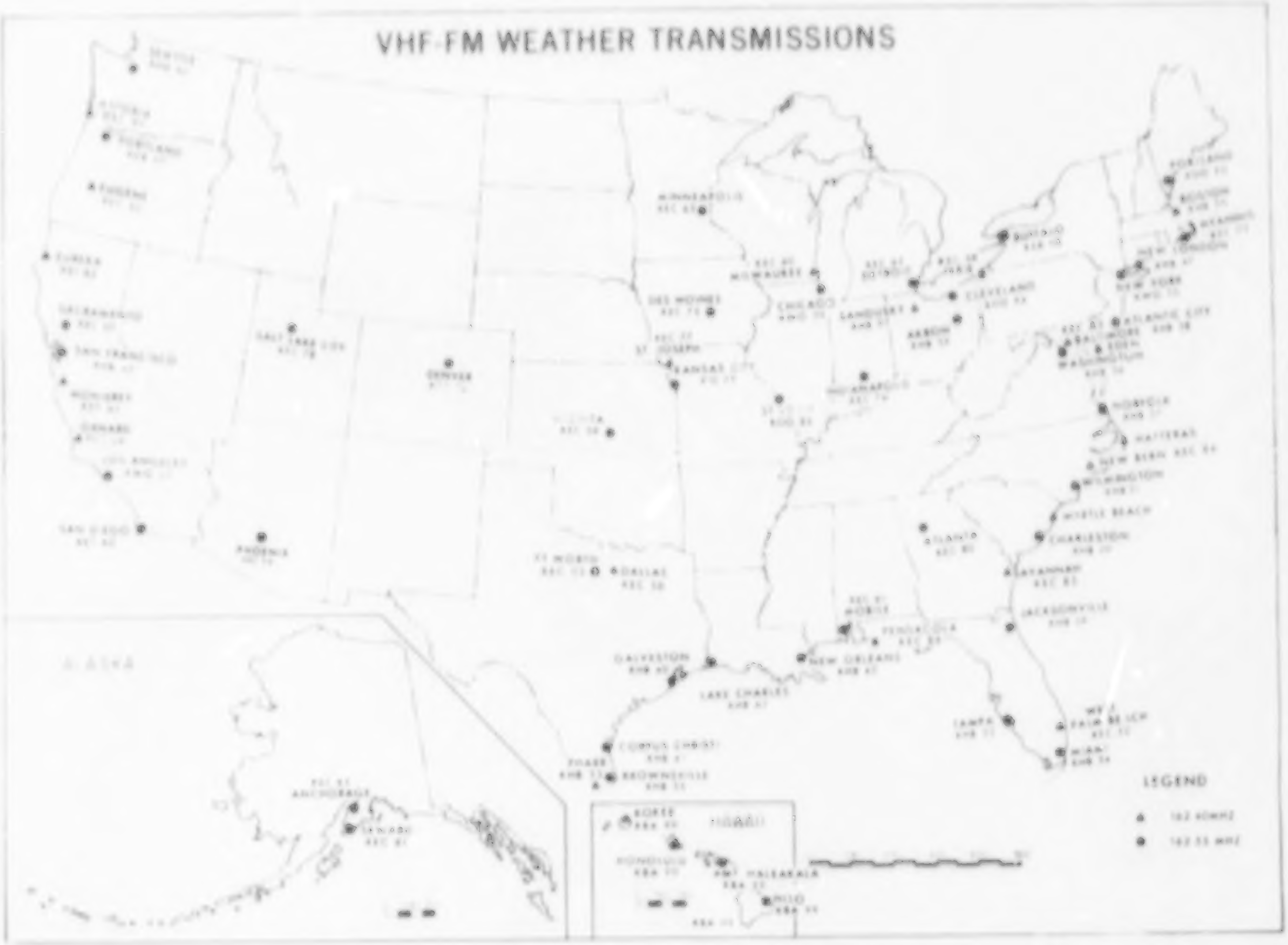
These systems are designed to reach as much of the public as rapidly as possible with warning information so that precautionary measures may be taken against the threatening weather event. Except in the case of sirens, the public must initiate action to receive the warning. The following public contact systems are employed:

VHF-FM Radio Continuous Weather Transmissions

-- to make weather and river information available to the public 24 hours a day and to provide positive alert by demuting receivers to warn of hazardous conditions;

Multiple Access Recorded Telephone Announcement Systems

-- to provide the public with a means for direct access to current warning, forecast, and observation information on an "on demand" basis by telephone;


VHF-FM WEATHER TRANSMISSIONS
SEATTLE
ASTORIA
PORTLAND
EUGENE
EUREKA
SACRAMENTO
SAN FRANCISCO
MONTEREY
OXNARD
LOS ANGELES
SAN DIEGO
SALT LAKE CITY
PHOENIX
DENVER
WICHITA
FT WORTH
DALLAS
MINNEAPOLIS
DES MOINES
ST JOSEPH
KANSAS CITY
ST LOUIS
MILWAUKEE
CHICAGO
DETROIT
SANDUSKY
AKRON
CLEVELAND
ERIE
BUFFALO
INDIANAPOLIS
PORTLAND
BOSTON
HYANNIS
NEW LONDON
NEW YORK
ATLANTIC CITY
BALTIMORE
WASHINGTON
NORFOLK
HATTERAS
NEW BERN
WILMINGTON
MYRTLE BEACH
CHARLESTON
SAVANNAH
ATLANTA
JACKSONVILLE
MOBILE
PENSACOLA
NEW ORLEANS
LAKE CHARLES
GALVESTON
CORPUS CHRISTI
BROWNSVILLE
TAMPA
WEST PALM BEACH
MIAMI
ALASKA
ANCHORAGE
SEWARD
HAWAII
KOKEE
HONOLULU
MT HALEAKALA
HILO
LEGEND
▲ 162.40 MHZ
● 162.55 MHZ

Mass Media (Radio, TV, Newspapers)

-- to reach as many people as rapidly as possible through the voluntary dissemination of warnings by radio and television with increased dissemination provided by newspapers; and

Sirens

-- to give communities a rapid and effective means of warning individuals in large urban areas who may not be listening to radio or television.

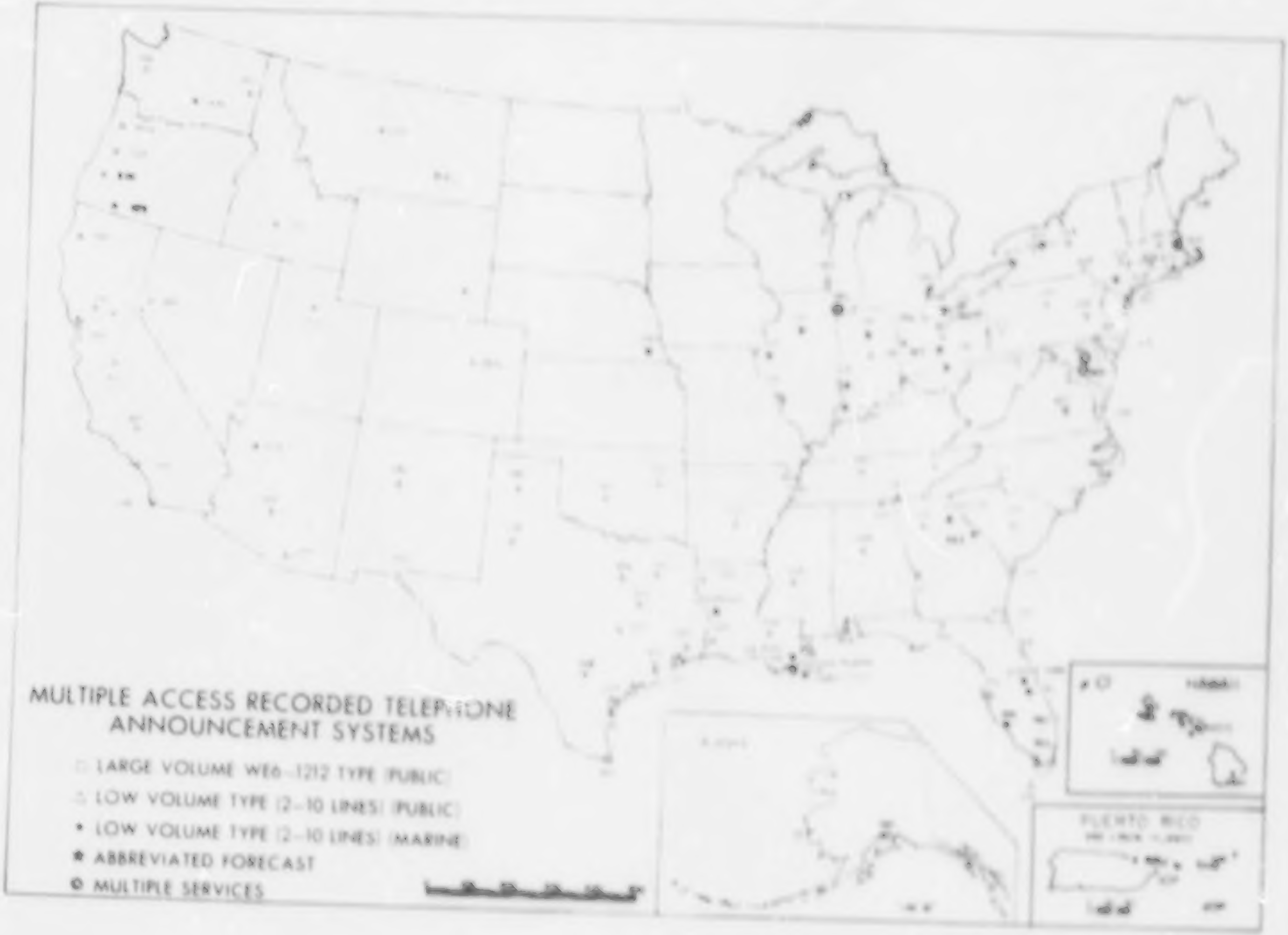
VHF-FM Radio

The NWS operates 65 VHF-FM radio systems which transmit continuously the latest forecast information to the public and selected public groups, such as marine interests. Locations are shown in an accompanying chart. Taped messages are repeated every four to six minutes and are updated at appropriate intervals. They are amended as needed. The transmissions are broadcast at frequencies of 162.55 MHz and 162.40 MHz from NWS offices, providing weather information over an area of about a 40-mile radius. Added dissemination is obtained by local radio and TV stations copying and rebroadcasting the material. Ideally, this is an effective warning dissemination system because transmissions are not disrupted by overloaded circuits, and the weather transmissions are continuous.

An added feature of this system is its alerting capability. The NWS office is able to turn on specially designed radio receivers by means of a transmitted tone signal. This signal is transmitted at 1050 Hertz for three to five seconds before announcements of hazardous weather conditions. The tone signal turns on radios to alert schools, hospitals, churches, and other places of assembly, public utility units, emergency forces, and news media to be ready for critically important weather messages. Tone-alert receivers are used extensively by such groups, for example, in Kansas City where the VHF/FM radio system has been available for several years. Public use of this alerting capability is expected to expand rapidly as more manufacturers put the specially designed receivers on the market.

Recorded Telephone Announcements

Multiple Access Recorded Telephone Announcement Systems provide one of the most accessible devices for disseminating weather information to the public. These systems are very effective for disseminating information on disasters such as hurricanes and severe winter storms, but they are of limited use in "short-fuse" situations such as tornadoes. Since the NWS has a limited number of personnel to answer the telephone, recorded weather announcements that can serve a large number of persons simultaneously are used. Three types of systems are included: large volume WE 6-1212 type, low volume type, and large volume type with abbreviated forecasts.



MULTIPLE ACCESS RECORDED TELEPHONE ANNOUNCEMENT SYSTEMS

□ LARGE VOLUME WE6-1212 TYPE (PUBLIC)
△ LOW VOLUME TYPE (2-10 LINES) (PUBLIC)
• LOW VOLUME TYPE (2-10 LINES) (MARINE)
★ ABBREVIATED FORECAST
⊙ MULTIPLE SERVICES
HAWAII
PUERTO RICO

The large volume WE 6-1212 type of system can handle 200 to 1,000 calls simultaneously. These systems normally have announcements (30 seconds or less) of interest to the general public and are provided by the telephone companies as a public service in 19 cities whose locations are shown on an accompanying chart. Forty more installations are planned in FY 1974. In an average year about half a billion calls are handled by these systems. As many as 668,000 calls have been handled in one 24-hour period by the Washington, D.C. system during periods of threatening weather.

The second type of recorded telephone announcement system, which is operated by the NWS from its service offices, is a low volume, limited access system. This system normally handles 2-10 calls simultaneously, and is used for local forecasts and specialized weather information, such as motorist forecasts, marine forecasts, and extended weather outlooks. Announcements on these systems are from one to three minutes in length. Telephone numbers are listed in local telephone directories. Locations of these systems are shown on the accompanying chart.

The third type of recorded telephone announcement is provided by large volume answering systems which provide abbreviated forecasts for the general public. These systems each contain 1,000 prerecorded forecast and warning messages which are programmed automatically into the system upon receipt of coded messages from the NWS forecast offices. The abbreviated forecasts are generally preceded by sponsored messages. These systems are installed and operated by telephone companies with funds obtained by selling sponsored messages. These devices are not placed in NWS service offices. Telephone numbers are listed in local directories.

Mass Media

Dissemination of warnings through the mass media (radio, TV, newspapers) is accomplished through the media's voluntary cooperation in distributing warnings received on the NAWAS or the national wire services (AP, UPI). The national wire services generally carry, as bulletins, the weather warnings received from the NWS. In most states, the wire services obtain weather warnings over NOAA-operated local teletypewriter circuits or the NAWAS.

Upon receipt of weather warnings over the NAWAS or the national wire services, most broadcasters voluntarily disseminate warnings affecting listeners or viewers in their areas. The management of specified broadcast stations at the state and local (or area) level may, at their discretion, release the Emergency Action Notification to participating stations in conjunction with weather watches and warnings. In addition, the Federal Communications Commission (FCC) has authorized standard broadcast daytime radio stations to operate outside their normal broadcast times to inform listeners of hazardous environmental conditions, if regular, unlimited-time service is nonexistent, inadequate from the standpoint of coverage, or not serving the public need. A number of broadcasters monitor the NOAA VHF-FM continuous transmissions in their areas, and rebroadcast forecasts or warnings received via this service.

The print media, by its nature, cannot respond adequately to weather warnings. Newspapers are not intended to be used for warning dissemination. They can provide useful general information such as for certain winter storms and hurricanes, providing a sufficiently long lead time is available. They can be very useful in such slowly developing situations by furnishing information essential to understanding broad weather trends and instruction and guidance on safety rules and protective measures. However, the print media are not suitable for warning dissemination.

Cable television offers considerable potential for dissemination of forecasts and warnings. Several cable television systems now have independent capability to continuously display weather forecasts and warnings for their areas on dedicated "weather channels". Forecasts and warnings are obtained via the NAWS and are displayed until updated.

Sirens

The siren system, programmed and installed under DCPA management, is designed to give local communities a rapid effective means of warning individuals. It is intended for use in densely populated urban areas as the most cost-effective method of reaching the man-in-the-street who may not be exposed to warnings broadcast by radio and TV.

The siren system would be used in conjunction with the NAWAS for dissemination of an attack warning. A recent State-by-State analysis of a test of their joint use revealed that 28 percent of the U.S. population would receive an attack warning within three minutes of its issuance on NAWAS, and 45 percent would receive it within 15 minutes. Activation of the sirens is controlled at the community level and may be done from one or more points, varying by communities. This makes the sirens available for local use in warning of impending natural disasters or other civil emergencies. In some instances, sirens can be activated directly by the National Weather Service facility responsible for issuing warnings of severe weather or floods in the area.

Until a reliable, unique warning dissemination system is available to meet the requirements of the public for weather warnings everywhere, a mix of NOAA VHF/FM radio continuous weather transmissions, multiple access recorded telephone announcement systems, mass media (radio, TV) and sirens is needed. However, no matter which system is used, the prompt and effective dissemination of warnings of "short-fused" phenomena such as tornadoes will be a challenge. It is planned to expand the VHF/FM Radio network to a total of about 175 through Fiscal Year 1978. These stations will be located in most of the large urban areas, especially those frequently affected by weather disasters, and in coastal areas having large amounts of fishing and recreational boating. The telephone industry recently established procedures and policies for the expansion of multiple access recorded telephone announcement systems sponsored by telephone companies. NOAA will cooperate with the telephone industry to increase the availability of weather and river information including warnings through the addition of telephone recorded announcement systems to complete about 70% of the planned systems through FY 1978. The mass media (radio, TV) are expected to continue their most vital, voluntary cooperation as a public service. The only planned expansion of the outdoor warning system is the addition of siren coverage to satisfy the requirements of projected population growth and urban development. Expansion of siren coverage relies on availability of local funds matched 50-50 with Federal funds provided through DCPA.

DECISION INFORMATION DISTRIBUTION SYSTEM

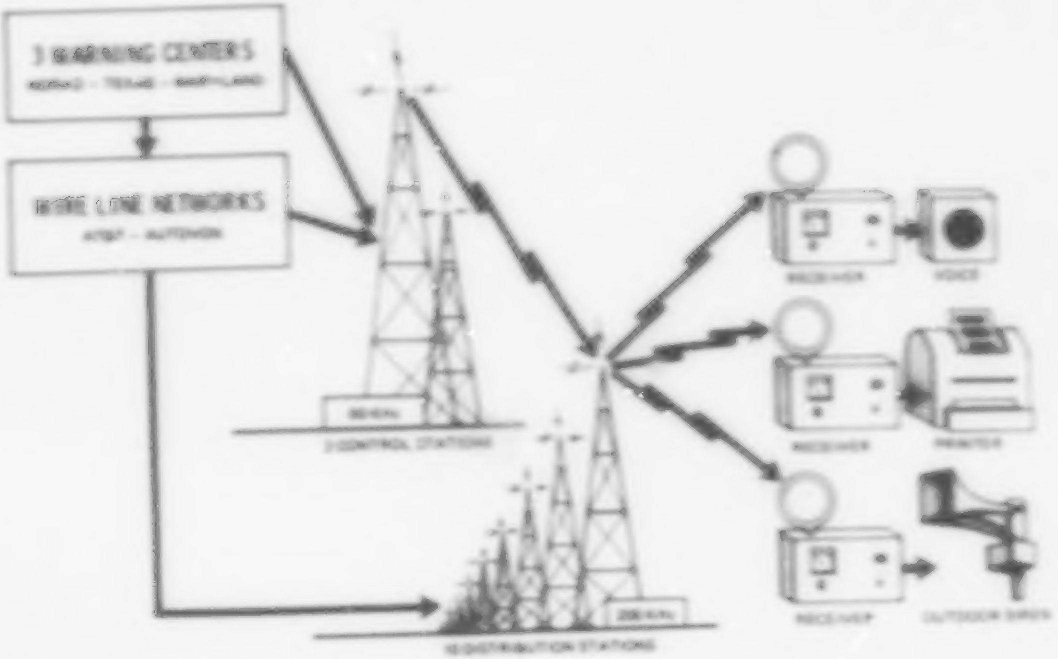
DIDS is a new, low frequency, high reliability, high survivability, automatic broadcast warning prototype system being developed by the DCPA. The DIDS was designed specifically to provide a capability for simultaneous nationwide issuance of attack warnings. Critical elements can be protected from blast damage and electromagnetic pulse effects of nuclear weapons. The specifications include a capability to demute receivers and deliver warnings by voice, teletypewriter and remote siren control 24 hours a day. The system was engineered for use also in distributing warnings of severe weather and other natural disasters on a highly selective area basis.

If fully implemented, population coverage in the conterminous United States would be up to 99% for siren control and up to 97% for voice messages. A systems plan and transmission coverage are shown on accompanying charts. For civil defense, the warning could be initiated from any of the 3 National Warning Centers. Studies are under way to determine optimal means to initiate severe weather warnings. The first distribution facility is under construction at Edgewood, Maryland. This facility will cover a 10-state area and is expected to start test transmission in the summer of 1973.

As currently planned DIDS will consist of three systems: a Control System made up of warning centers operating consoles in real-time system operations displays, leased wire services, and 2 high power (200KW) low frequency (61.15 kHz) control transmitters; a Distribution System consisting of 10 medium power (50KW) low frequency (167, 179, 191 kHz) distribution transmitters which provide 48-state coverage; and the Receiver System consisting of voice receivers, voice plus teletypewriter or tape record/playback receivers and automatic control units for community sirens and city siren systems. The Control System activates the Distribution System and the latter activates the Receiver System.

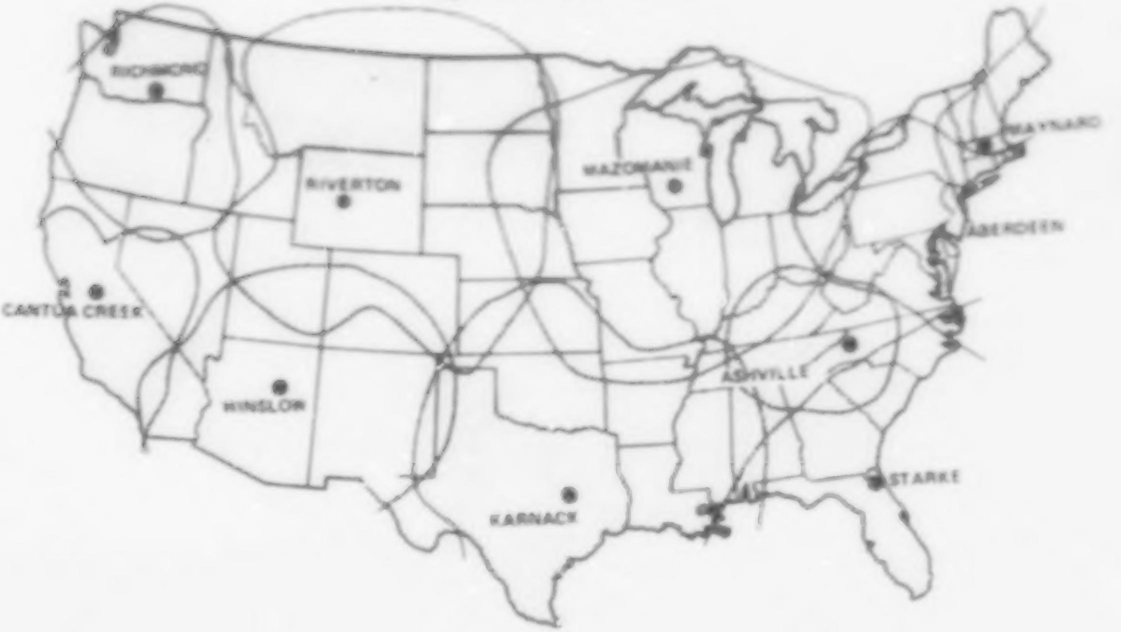
Present plans call for approximately 20,000 voice receivers, 12,000 voice plus teletypewriter or tape, and 5,000 siren controls. Receivers can be located at national, state and local emergency operating centers, federal and state agencies, national and local warning points, state adjutant and military headquarters locations, and broadcast radio and television stations. Receivers can be "turned on" (demuted) or "turned off" (muted) remotely by the DIDS transmission system, in accordance with preset codes which provide for activation of receivers geographically (national, regional, state, local) and/or in accordance with function (government, public, industry, military). A given receiver may be equipped for activation on eleven of the codes.

SYSTEM PLAN FOR DIDS


3 WARNING CENTERS
NORAD – TEXAS – MARYLAND
WIRE LINE NETWORKS
AT&T – AUTOVON
60 KHz
2 CONTROL STATIONS
200 KHz
10 DISTRIBUTION STATIONS
RECEIVER
VOICE
RECEIVER
PRINTER
RECEIVER
OUTDOOR SIREN

DIDS TRANSMISSION COVERAGE

High Reliability Service


RICHMOND
MAYNARD
MAZOMANIE
RIVERTON
ABERDEEN
CANTUA CREEK
ASHVILLE
WINSLOW
STARKE
KARNACK

Similar receivers for use by the general public are under development and are expected to have a low first cost when produced in large quantities. However, use of the DIDS will require optional procurement of receivers by users.

DISASTER WARNING SATELLITE SYSTEM

In a coordinated effort, NOAA and NASA have conducted preliminary investigations of the feasibility of using a communications satellite as a Disaster Warning Satellite System (DWSS) to selectively broadcast disaster warnings. The requirements for a proposed DWSS might also include:

- disaster communications among Weather Service Forecast Offices, Weather Service Offices, National Warning Centers, River Forecast Centers, Weather Service Meteorological Observatories and local areas;
- a means for alerting the general public as to what to do when a disaster strikes;
- a system for collecting data and feedback information upon which decisions to issue warnings are based;
- broadcasts of weather forecasts and environmental information.

Data collected during disaster occurrences or threats would include information from spotter networks consisting of police, fire, civil defense and local authorities; from hurricane reconnaissance aircraft; and from some 20,000 automatic data collection platforms.

The potential advantages of the application of satellite technology to disaster warning have been investigated in preliminary studies which indicate the desirability and need for further, more detailed study. Therefore, feasibility studies, based on NOAA developed system requirements, have been initiated. NOAA is to fund these studies in FY 1974 while NASA is to provide technical support as requested, and as resources permit. Results of the feasibility study will be weighed in evaluating the desirability of developing a proposal for a DWSS for the 1980's.

Part IV - Community Preparedness

Community preparedness functions are readily separated into two areas, assessments and planning. Just as monitoring is the basis for prediction and warning services, assessments are the essential first step to the preparation of adequate preparedness plans. The programs for the preparation of risk assessment information carried out by each of the agencies on the different types of disasters are discussed in this section.

The OEP Report to Congress on Disaster Preparedness identified the need for preparedness plans at all levels and strongly emphasized the need at the State and community level. OEP coordinates planning at the National level and by memorandum of understanding has delegated to DCPA the responsibility for developing a coordinated Federal program for planning assistance to local communities. The DCPA effort to provide Local Government On-Site Operational Assistance involves planning for both wartime and natural disaster emergencies. Because of the major NOAA role in natural disaster warnings and parallel responsibilities for preparedness planning for natural disasters, extensive DCPA/NOAA coordination is conducted. A formal agreement is being developed to establish standard procedures for interagency DCPA/NOAA coordination at National and Regional levels and NOAA participation in DCPA On-Site Assistance.

A. ASSESSMENT

Assessments of the threat of natural disasters are essential to support the preparation of adequate preparedness plans at all levels. Risk assessment becomes the primary tool in mitigating the impact of those disasters for which timely and reliable warnings are not usually available. Federal, State and local community governments must assess and evaluate the potential disaster risks to which they are exposed before planning requirements and resource priorities can be determined. The requirements even extend to individuals as they weigh the needs for storm proof construction, insurance and personal protective shelters. To satisfy these requirements, risk assessment programs are conducted by Federal agencies. A discussion of these programs is given in the following paragraphs.

HURRICANES AND STORM SURGES

Assessments of the threat of hurricanes and storm surges are essential to adequate protection planning at the community and state level along the coastal zones. To satisfy these requirements the NOAA National Ocean Survey has a continuing program for the preparation of hurricane evacuation charts for the Gulf of Mexico and Atlantic coastlines. Charts have been completed for three sections of the Gulf coast and will continue until the entire coastline has been covered. These charts provide basic guidance for developing evacuation plans, especially in the densely populated areas with low elevations. In some areas of high population density horizontal evacuation may be impractical such as in Dade County, Florida where full

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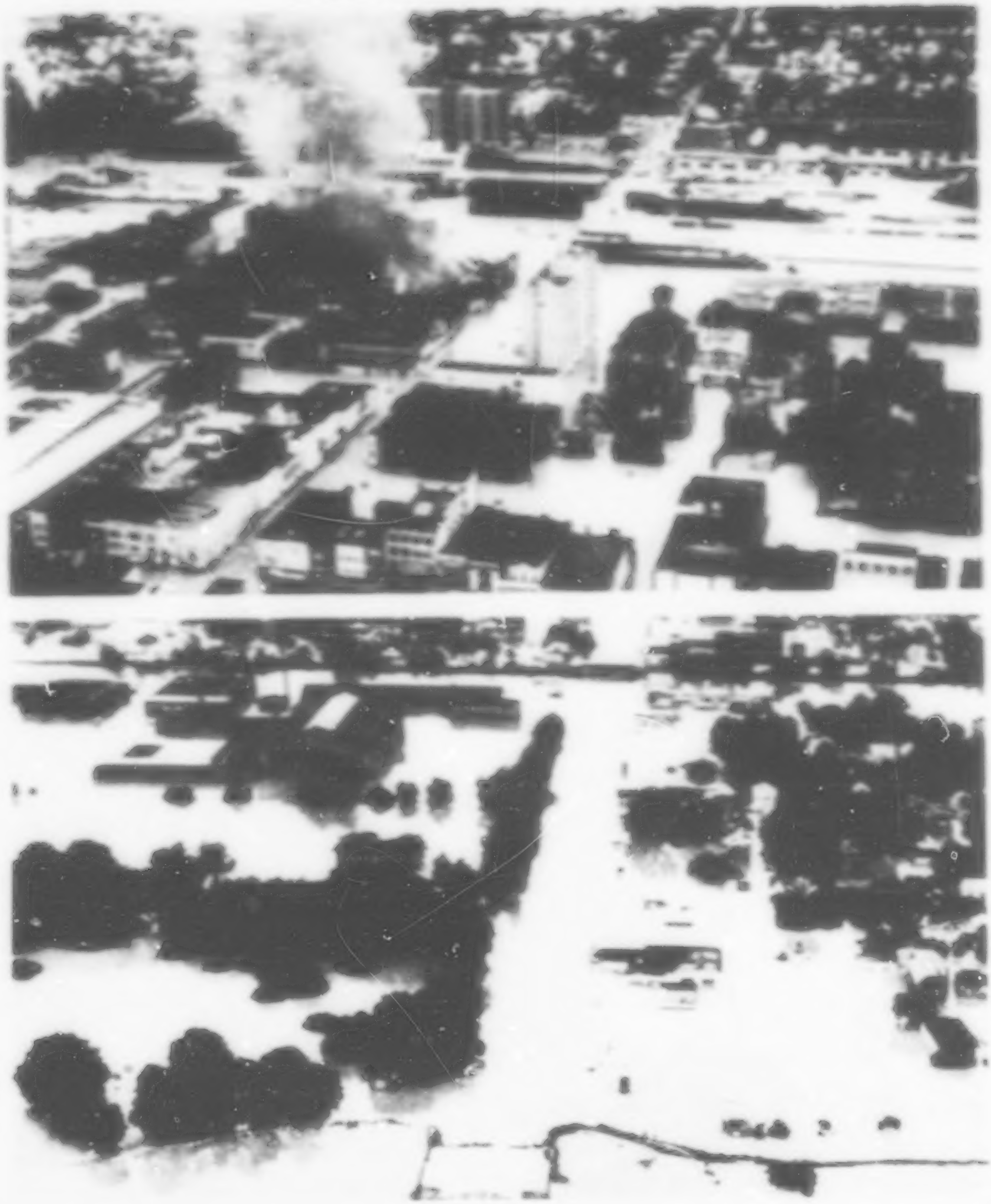
The raging Susquehanna River flooded by Hurricane Agnes caused millions of dollars of damage to Wilkes-Barre, Pa.

Official U.S. Coast Guard Photos



assessment of the threat has led to the development of a vertical evacuation plan. Flood plain management studies done by the Corps of Engineers help delineate the danger zone and assist in the designation of evacuation routes. The NOAA Environmental Data Service furnishes statistical data on the frequency of occurrence and severity of storms by coastal section for use in risk assessment and policy considerations on building codes and land use programs.

TORNADOES AND SEVERE LOCAL STORMS

The National Weather Service maintains and publishes statistics on the frequency of occurrence of tornadoes and severe local storms for use in risk assessment and preparedness planning. Because tornadoes are small, violent, develop rapidly and are of relatively short duration, neither evacuation nor boarding up measures are practical means of reducing the damages and deaths they cause. Thus, mitigation of their impact on economic losses is almost entirely dependent on the availability and proper use of risk assessment information.

SEVERE WINTER STORMS

Assessment of the potential risks of severe winter storms and the development of preparedness plans to mitigate their impact are vitally important to a wide cross-section of economic and social activities, the general public and government at all levels. Although the actual destruction they cause may be light by comparison with hurricanes or tornadoes, the economic losses due to severe winter storms reach major proportions. The costs of snow and ice removal, agricultural and livestock losses, curtailed industrial production and reduced retail sales amount to many millions of dollars each year. Risk assessment information to support preparedness planning in the form of statistics on frequency of occurrence, severity and duration of severe winter weather is furnished by the Environmental Data Service.

RIVER AND FLASH FLOODS

Flood control measures of a preplanned permanent nature as well as land use programs regulating building by location or design are effective in reducing the loss of life and property due to floods. Such actions must be based on an assessment of the threat or risk for each locality. The Army Corps of Engineers, the U.S. Geological Survey and the Department of Agriculture have active programs to furnish information needed for such planning purposes.

To assist in flood plain management, the Corps of Engineers publishes flood plain information reports for communities with flood problems. Some 5200 localities have been so identified. The Soil Conservation Service, USDA, provides similar flood hazard information to rural communities as by products of efforts directed toward survey, analysis and monitoring conducted for other purposes. The USDA program is complementary to that of the Corps of Engineers and is closely coordinated with the latter agency. In addition, the Corps responds to thousands of requests each year for interim information on specific development sites and short stretches of streams or coast. Through its Bureau of Reclamation the Department of Interior constructs and operates systems of dams, reservoirs, and water conveyance systems in 17 Western States and Hawaii. Their multi-purpose nature provides regulatory features for flood control. The U.S. Geological Survey also has a flood plain mapping program to aid in identifying areas of flood inundation to support community planning.

EARTHQUAKES

Earthquake assessment programs are directed toward providing information on the expected recurrence of damaging earthquakes, their probable magnitude, descriptions of significant geologic features and the response to zones of different geologic materials to seismic excitation. Basic information on hazard assessment is presented as maps such as the accompanying seismic risk map, and other products especially designed as inputs to land use planning (zoning) and specifying engineering practices and construction standards (codes) to insure that earthquake hazard is evaluated in determining acceptable use of land in high risk areas and critical structures reflect latest knowledge in damage resistance technology.

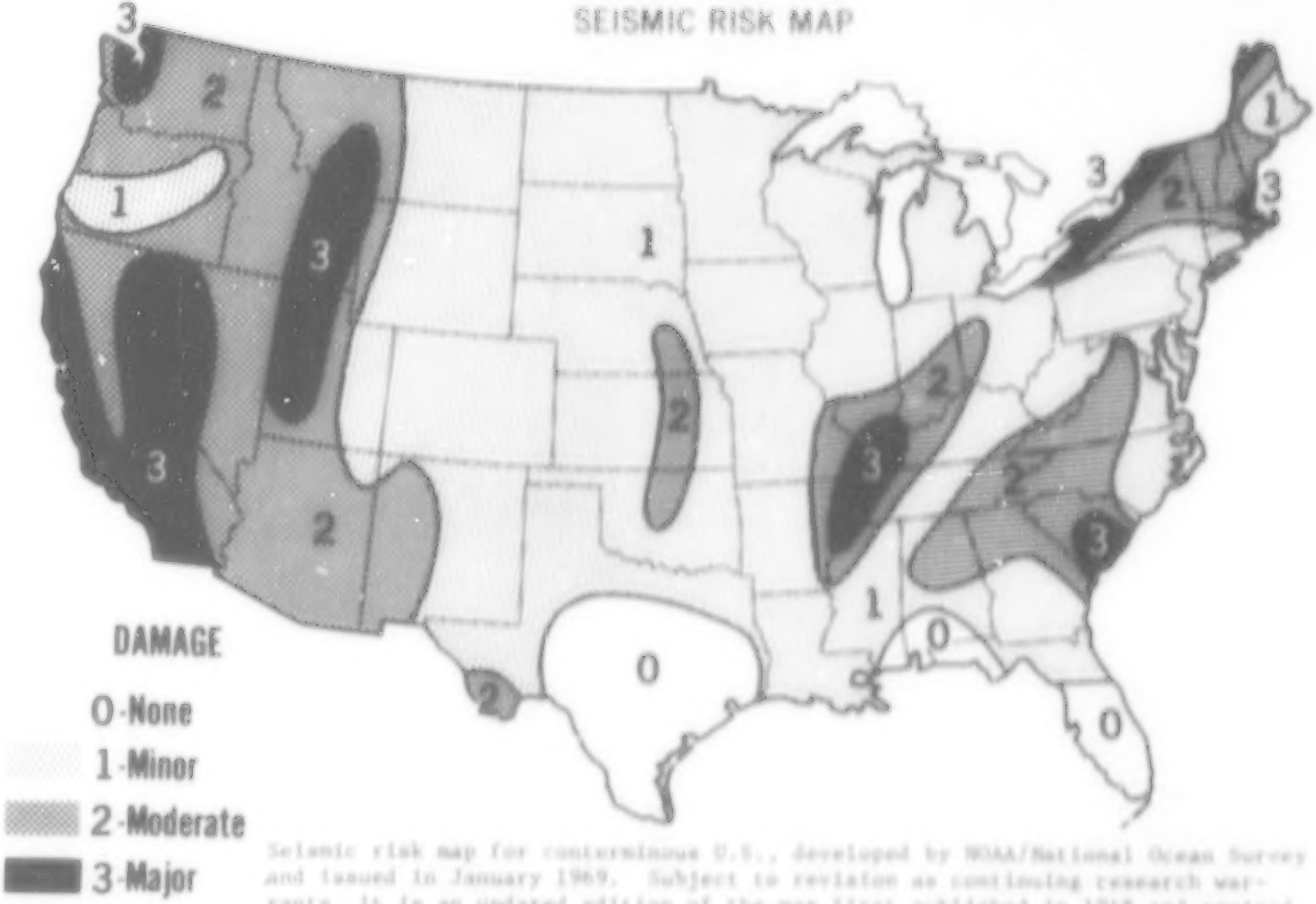
Information on earthquake recurrence, damage patterns, ground amplification, faulting and other crustal deformation, and geologic mapping is considered in preparing seismicity maps, seismic risk maps, and geologic hazards maps. Efforts are underway to identify further specific information needs of local officials, engineers and scientists.

The essential elements of earthquake hazards assessment are included in the program of the National Center for Earthquake Research, USGS. Integrated studies are conducted utilizing geologic and seismic techniques on such topics as: delineation of active faults; estimation of earthquake recurrence intervals, maximum magnitude, and bedrock ground motion; influence of soil conditions and geologic setting on ground motion and failure; post-earthquake field investigations of damaging earthquakes; earthquake prediction; and earthquake control. Critical data are gathered by an extensive instrumentation system of over 200 seismographs, tiltmeters, magnetometers, and strain monitoring networks, and comprehensive mapping programs to delineate the physical properties and behavior potential of geologic deposits in critical localities.

Under OEP contract, the National Oceanic and Atmospheric Administration (NOAA) completed a damage analysis study for a range of earthquakes (6, 7, and 8.3 on the Richter scale) on the San Andreas and Hayward Faults in the nine-county San Francisco area. With completion of the NOAA study, OEP organized a planning group composed of 29 Federal agencies to prepare a Federal earthquake response plan for the Bay area. Concurrently with the Federal effort, the State of California, under contract with OEP, is developing a State response plan for that area. Pending completion of these two concurrent efforts by the fall of 1973, an interim Federal response plan is being prepared to support State operations in event of an earthquake. The techniques evolved in this study will be applied to other high risk areas in the United States.

Assessments of any current damaging earthquakes are provided through a

SEISMIC RISK MAP


3
2
1
3
3
2
1
2
3
2
3
1
0
0
1
0
3
2
3
2
1
3
DAMAGE
0-None
1-Minor
2-Moderate
3-Major

Seismic risk map for conterminous U.S., developed by NOAA/National Ocean Survey and issued in January 1969. Subject to revision as continuing research warrants, it is an updated edition of the map first published in 1948 and revised in 1951. The map divides the U. S. into four zones: Zone 0, areas with no reasonable expectancy of earthquake damage; Zone 1, expected minor damage; Zone 2, expected moderate damage; and Zone 3, where major destructive earthquakes may occur.

Assessments of any current damaging earthquakes are provided through a program of comprehensive, real-time, reliable information to disaster relief agencies, scientists and the public. This information includes the location, magnitude and effects of damaging earthquakes to enable Federal, State, and local officials to marshall their resources for prompt relief of disaster victims and for planning the economic recovery of the devastated areas.

This service is provided by the National Earthquake Information Center, Boulder, Colorado, which receives seismic data from a number of observatories and locates by computer all magnitude 6 1/2 and larger earthquakes around the world and many magnitude 5 and above earthquakes in the conterminous U.S. Within one to two hours after the event, NEIC reports this information to the OEP, Red Cross, State AID Disaster Relief Coordinators and other emergency, scientific, and public information channels. Damage reports, when received are disseminated to the same recipients. Domestically, these releases are by telephone and over the RAWARC network, and internationally over the World Meteorological Organizations Global Telecommunication System.

Data from the U.S. National Seismic Observatory Network (31 stations) and from the cooperating World-Wide Standardized Seismograph Network Stations and other stations are used to provide an international Preliminary Determination of Epicenters' Service, which includes publications at bi-weekly and monthly intervals summarizing recent earthquake events. These data support seismicity studies and construction of regional seismicity maps.

Presently, a network of 700 accelerographs and displacement meters principally in the western U.S. with some in the east and in South America supports assessment of intensity of seismic events. These instruments are variously placed in buildings and other structures and on different types of ground. Additionally, there are 400 seismoscopes, an inexpensive instrument giving supplementary information from one point on the velocity spectra.

A program of contracts and grants with universities, engineering firms and consultants is undertaken to provide specific answers to questions of interest in the risk and hazards assessment program. This includes engineering damage assessments after destructive earthquakes.

Present products and services are useful but the optimum form for this information is still being developed. Basic data are inadequate for many geographic areas, and hazards evaluation and mapping programs are needed for completion of detailed assessment in all high risk areas within the next two decades. A greater density of instruments is also needed to develop a more thorough knowledge of seismicity in the lower magnitude range which is essential in the development of seismic risk maps on regional and local scales.

Future USGS efforts will be directed toward assessment of hazards and publication of detailed regional and local risk maps of all moderate to high risk areas, incorporating the best technology available from all sources inside or outside the government. This program will be accelerated through the use of contracts when possible.

Earthquake damage San Fernando, California 1971.

Tsunami damage Kodiak, Alaska 1964.

All significant earthquakes will be promptly reported through the NEIC which will accelerate the collection and delivery of field and damage data to disaster relief agencies by using automated collection and computer processing of data. Also, detection services will be augmented including seismic monitoring, development of advanced techniques for location and description of earthquakes, and improved capability for data display and dissemination.

The monitoring networks of strong motion instruments will be augmented and extended. The number and location of stations is the subject of a joint study by NOAA, NSF, and the Committee on Seismology of the National Academy of Science. Approximately, 800 instruments will be added through FY 1978.

Supporting research needed for improved assessment services includes the development of improved techniques for use in the earthquake hazards assessment program with emphasis on improving the significance of data presented on risk maps in terms of its practical applicability to real problems; research by the National Earthquake Information Center in techniques to allow rapid estimate of damage for a given magnitude and location, in ways to improve both routine and special hypocenter determination and in improved damage information collection systems; and the development of systems of unmanned or remote reporting sensors for intensity and strong motion data, as well as routine observations.

TSUNAMIS

Assessment of the potential risks of tsunamis is important to the preparation for essential decisions and actions when tsunami watch or warning bulletins are issued. The community at large needs to be informed of tsunami danger areas. One method of serving this need has been utilized in Hawaii where maps of possible tsunami inundation areas are printed in the telephone directories. The State of California Division of Mines and Geology is attempting to delineate tsunami hazards in California. The U.S. Army Corps of Engineers is undertaking studies with a view toward assessment of possible tsunami inundation over an extended period of time and also the design of protective structures to reduce tsunami damage.

VOLCANOES

The areas that have been devastated by past volcano eruptions are mapped to delimit zones subject to the recurrence of a disaster. In Hawaii the results of active volcanism are fairly obvious but human activity tends to encroach on quiet portions of the volcano flanks. In the Pacific Northwest, several volcanoes are inactive but not dead; some areas susceptible to disaster have not been recognized and risk mapping provides the basis for planning land use an. evacuation routes. Federal programs for risk mapping are the responsibility of the U.S. Geological Survey.

LANDSLIDES

Landslides represent a widespread danger to life or loss of property in the U.S., particularly where they occur as secondary effects of earthquakes. Slides are generally localized and do not occur frequently in most localities. Warnings of landslides generally are not feasible but have been issued where ground cracking has been observed. Local surveillance suffices in many areas. It is therefore important that local officials, builders, disaster-preparedness organizations, and the community at large have available and use maps and reports which locate and analyze the nature and extent of the landslide risk. This information must be presented in such terms and such form that it is comprehensible and useful to the intended users. Federal programs for landslide risk mapping are the responsibility of the U.S. Geological Survey.

Areas known to be susceptible to landslides because of events in the historic past are subjected to visual surveillance by special groups such as highway maintenance crews and forest rangers. Areas unusually prone to slides, like the California coastal areas, are being mapped to delineate potential slide sites. A few potential landslide sites are instrumented to detect early signs of movement or conditions which promote movement.

A more systematic analysis of available information on landslides and slide-prone areas would yield a better assessment of the national distribution of risk. This would permit extension of mapping programs to additional areas of known susceptibility and the delineation of potential slide sites would sharpen the surveillance and assist in land-use planning and in engineering design. Suitable sensors, especially for ground water conditions, should be systematically used in high-risk areas where concentrations of population or important structures are imperilled.

Sensors to monitor groundwater conditions in slide-prone areas are being investigated. Aircraft and satellite surveying and monitoring systems are under study as aids in identifying slide-prone areas and observing changes in their condition. Research on the mechanisms and geometry of different kinds of slides and slides generated in different geologic materials will yield improved models for predicting landslide conditions.

B. PLANNING

The effective mitigation of the impact of natural disasters depends in large part on the adequacy of community plans for action when disasters are expected and when they occur. Comprehensive, reliable plans are essential for developing the high degree of responsiveness for marshalling of resources and for coordination of actions on an emergency basis. In recognition of the importance of community planning the Federal goverment plays a major role in assisting planners at the State and local level. A discussion of the Federal Agency programs in community planning follows.

FEDERAL

"The Disaster Relief Act of 1970", Public Law 91-606, 91st Congress, S. 3619, December 31, 1970, establishes broad Presidential powers "**to provide an orderly and continuing means of assistance by the Federal Government to State and local governments in carrying out their responsibilities to alleviate the suffering and damage which result from such disasters by -----------encouraging the development of comprehensive disaster relief plans, programs, and organizations by the States; and achieving greater coordination and responsiveness of Federal major disaster relief programs ---." Executive Order No. 11575, January 5, 1971 providing for the Administration of the Disaster Relief Act of 1970, delegates to the Director of the Office of Emergency Preparedness authority for all actions concerning assistance to State and local governments in preparedness planning and coordination of Federal Agency programs; and delegates to the Secretary of Defense authority for actions concerning the use and availability of the civil defense communicating system for the purpose of disaster warnings. Reorganization Plan No. 1 of 1973 which is not yet fully promulgated will assign to the Department of Housing and Urban Development most of the authority and responsibility for disaster planning and assistance now assigned to the Office of Emergency Preparedness.

The Office of Emergency Preparedness is engaged in a series of interagency committee planning actions at the national level directed toward assisting community efforts to achieve better preparedness plans and capabilities to cope with natural disasters. The OEP Report to Congress on Disaster Preparedness in January 1972 may well be termed a 'landmark study' for its comprehensive treatment of the total disaster preparedness problem. Among other things, it pointed to the need for improvement in disaster preparedness planning with the greatest need at the local level, and full coordination of Federal agencies programs with State and community programs. While coordination at the national level is carried out through a series of interagency committees chaired by OEP, responsibility for Federal programs in community preparedness at the local level has been assigned to DCPA as a result of bilateral agreements between the Director OEP and the Secretary of Defense.

LOCAL

"Planning is essential for any region or community likely to be affected by a disaster in order to determine what preventative and protective measures can and should be taken before and at the time of a disaster. ***The greatest need is at the local level***."

The above quote is from the Office of Emergency Preparedness (OEP) "Report to the Congress on Disaster Preparedness," dated January 1972. The Defense Civil Preparedness Agency (DCPA) strongly endorses the statement above and recognizes that there must be renewed efforts upon the part of the Federal Government in this area of concern. The current redirection of effort of civil defense aims at improving the ability of local governments to respond rapidly and effectively to save lives and protect property in the event a locality is threatened or actually hit by any kind of disaster--whether a major peacetime emergency or enemy attack upon the United States.

The DCPA concept of civil defense today is that it must be an integral part of society: that it give the taxpayer a continuing return on his investment--and that it can be useful as protection in peacetime disasters as well as insurance against the effects of nuclear attack. The major element in the DCPA new program to reach these goals is on-site assistance.

The objective of On-Site Assistance (full title: Local Government On-Site Operational Readiness Assistance) is to help local governments (countries, cities, towns) in improving their capability to conduct coordinated operations in emergencies, including natural disasters and other peacetime emergencies as well as nuclear war. This priority effort is one of the primary redirection activities which began in FY 1972 and is being emphasized for FY 1973. It is described as "individualized on-site assistance by Federal and State staff members to selected localities in assessing their existing level of operational readiness and in preparing and executing plans to improve readiness."

On-Site Assistance involves direct on-site (at the locality) Federal and State effort, and consists of a number of specific steps, such as assessing existing capabilities (for example, emergency communications); surveying local needs (for example, warning systems) and developing action plans to meet requirements identified. The aim is to give concrete and immediate assistance, in addition to comprehensive long-range readiness help, taking maximum advantage of existing Federal, State, and local resources; e.g., the surplus and excess property programs, and planning, training, and technical assistance. Thus, where on-site review shows gaps between resources and the potential emergency need, DCPA financial and technical assistance programs, training and education facilities, and surplus and excess property programs can bring assistance. Whenever possible, other Federal agency resources are tapped to reach the goals of increased local emergency operational capability.

Achievements in On-Site Assistance during its brief history are encouraging. As of January 1, 1973, visits by joint Regional DCPA/State cviil defense teams have been made or scheduled for 412 localities in 49 states and 136 Action Plans have been approved. These are the instruments designed to help the community develop readiness to cope with both peacetime and war disasters.

This joint Federal, State and local effort in emergency preparedness will be coordinated at the national level in accordance with procedures established by the Office of Emergency Preparedness. Under DCPA leadership, coordination at the local and regional levels with field offices of other Federal agencies will insure full exploitation of their disaster related programs in the community preparedness effort. This coordinated effort will direct special attention to the need for effective systems to disseminate warnings at the local level. These programs of the Departments of Agriculture, Commerce, Defense, and Interior, and the Tennessee Valley Authority and River Basin Commissions are described briefly below:

Department of Agriculture (USDA)

The USDA has the major role in programs for watershed improvement. These programs are intended to reduce water and sediment runoff, maintain desirable streamflow conditions, protect water quality and maintain soil quality at a high level and control erosion. The program also includes authority to spend a total of $300,000 annually to undertake emergency measures (Flood Control Act, June 28, 1938).

Potential avalanche and flood source areas and areas which exhibit characteristics associated with mass earth and ice movement and flooding are identified as a part of the normal geologic, hydrologic and soils inventory activities. Information provided by these inventories are used in land use planning where the hazards from these naturally occurring phenomena are fully recognized.

While not necessarily a hazard imposed by catastrophic events, information related to ice conditions on lakes, ponds, and rivers and on water quality are an important part of the Forest Service effort to detect and alleviate hazards to users of the National Forests.

Hazards imposed by glacial activity are also of direct concern to the Forest Service. An operating plan has been developed to avert a potential disaster related to an increasingly active glacier in Alaska. A proposal to monitor glacial movement has been developed to provide predictions as to anticipated changed conditions and to provide a base for evaluating alternative means of mitigating effects.

Department of Commerce (DOC)

In addition to providing the nation's warning service of impending natural disasters, NOAA has active programs designed to assist communities and individuals in preparedness planning. In recognition of the extensive NOAA responsibilities in community preparedness, a DCPA/NOAA memorandum of understanding on program concepts and coordination procedures has been developed. In addition a full-time NWS liaison position has been established at DCPA Headquarters to give impetus to the program.

NOAA's preparedness programs are carried out primarily through the field offices of the National Weather Service. At the community level activities are directed at three objectives - public education on personal safety rules and protective shelters - fast reliable warning dissemination - and plans for post disaster activities.

The National Weather Service has an active program directed at public education and safety. Informational booklets, pamphlets, and posters on natural disaster safety precautions are widely distributed through NWS field offices and local government and civic groups. Films, records, and spot announcements for radio and TV are also used. The program is given emphasis seasonally for different types of storms in the areas they most frequently occur through presentations by NWS representatives at various civic group meetings, special news media broadcasts and community preparedness planning meetings.

Hurricane preparedness specialists have been assigned to each of the five Atlantic Hurricane Warning Offices to assist communities in their areas of responsibility in organizing their preparedness efforts. Additional specialists are programmed for assignment to Weather Service Forecast Offices each year through 1978. These specialists emphasize the need for fast, reliable dissemination and adequate disaster plans as they work in close coordination with the DCPA On-Site Assistance effort; perform surveys to determine requirements for flash-alarm devices; assist communities in developing self-help flash flood warning systems; train tornado and severe storm spotters and organize reporting networks; participate in public education programs on the threats of each type disaster and personal safety rules for each; and advise and assist local and state authorities in planning and establishing emergency procedures and facilities.

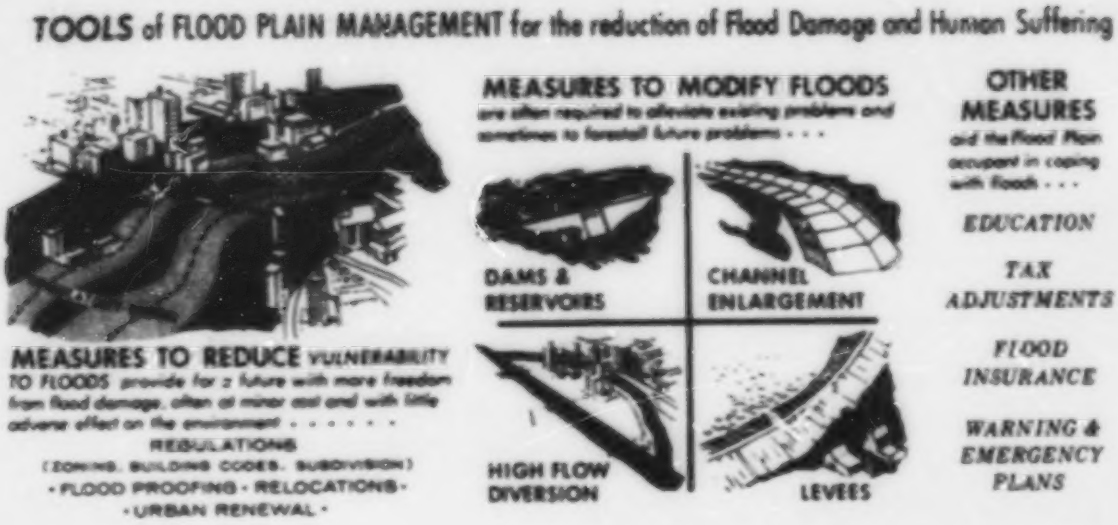
Corps of Engineers

The U.S. Army Corps of Engineers has the primary statutory responsibility for the development and construction of engineering flood control projects and the operation of river regulatory works on "tributaries of navigable rivers". Exceptions are areas of the Tennessee Valley Authority and certain areas in the west under the responsibility of the Department of the Interior. During the period of a flood or flooding potential, the Corps relies on information furnished by the National Weather Service to carry out its flood control operation of reservoirs and evaluate the need for emergency actions such as sandbagging.

To assist in flood plain management the Corps of Engineers publishes flood plain information reports for communities with flood problems. Some 5200 localities have been so identified. The Soil Conservation Service, USDA, provides similar flood hazard information to rural communities. The USDA program is complementary to that of the Corps of Engineers and is closely coordinated with the latter agency. In addition, the Corps responds to thousands of requests each year for interim information on specific development sites and short stretches of streams or coast.

Department of Interior (USDI)

Through its Bureau of Reclamation, the USDI constructs and operates systems of dams, reservoirs, and water conveyance systems in 17 Western States and Hawaii. Their multi-purpose nature provides regulatory features for flood control. The Geological Survey also has extensive flood plain mapping programs



TOOLS of FLOOD PLAIN MANAGEMENT for the reduction of Flood Damage and Human Suffering

MEASURES TO REDUCE VULNERABILITY TO FLOODS provide for a future with more freedom from flood damage, often at minor cost and with little adverse effect on the environment . . . .

REGULATIONS
(ZONING, BUILDING CODES, SUBDIVISION)
• FLOOD PROOFING • RELOCATIONS •
• URBAN RENEWAL •

MEASURES TO MODIFY FLOODS are often required to alleviate existing problems and sometimes to forestall future problems . . .

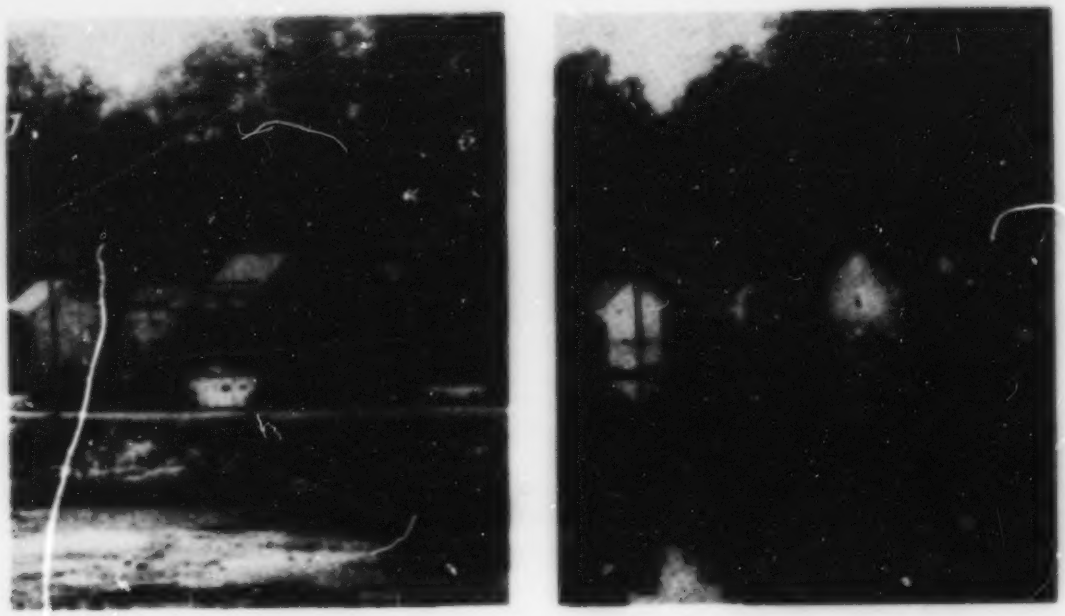
OTHER MEASURES aid the Flood Plain occupant in coping with floods . . .

EDUCATION

TAX ADJUSTMENTS

FLOOD INSURANCE

WARNING & EMERGENCY PLANS



Houses normally high and dry above Bushkill Creek, Easton, Pennsylvania are easily accessible by boat during the 1955 flood.

to aid in identifying areas of potential flood inundation for community planning. Maps showing the areal extent of the flood of a size that has a one percent chance of exceedance in any year are prepared at a rate of about 1,000 per year on a 1:24,000 scale.

Tennessee Valley Authority (TVA)

The TVA is responsible for flood protection in the Tennessee River Valley (TVA Act of 1933). Flood protection encompasses an extensive multi-purpose river regulatory system of 30 dams and local engineering work providing flood protection along 750 miles of the Tennessee River.

River Basin Commissions

The Water Resources Planning Act of 1965 authorized the establishment of federal-state commissions for reporting to the President through the Water Resources Council. These commissions consider the problems of flood hazards on a regional rather than a local basis and are concerned with the entire range of water control and associated land use to provide integrated management on a regional basis. All levels of government are involved in this coordinated approach to water management and flood control.

Part V - Program Implementation

Costs and Benefits

This part of the Plan presents the implementation costs of programs planned to satisfy unmet needs and a description of the expected benefits. It has been prepared in three sections. Section A contains actions programmed by each agency that respond to specific findings of the OEP Report to Congress on Disaster Preparedness. Section B represents each agency's costs and Section C describes the anticipated benefits of the planned programs.

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Section A

ANALYSIS OF OEP FINDINGS VS FEDERAL PROGRAM INCREASES FY 1973-FY 1978

FINDING	FY 1973 PROGRAM INCREASES	FY 1974 PROGRAM INCREASES	FY 75-78 PROGRAM ESTIMATES*	REMARKS
11-2 Disaster preparedness plans and programs of many states and localities need to be improved. To help accomplish this, PL 91-606 authorized matching funds for the development and maintenance of State disaster plans. The recent steps by OEP and the Council of State Governments to provide guidance and encouragement to the States to upgrade State and local disaster plans, with greater emphasis on preparedness, should lead to community and nationwide improvements.	DCPA Defense Civil Preparedness Agency is sending On-Site Assistance Teams to local governments to (1) assess existing capabilities, (2) to survey local needs, and (3) develop action plans to meet requirements identified. This redirection of effort involves most DCPA programs and no funds are programmed specifically for On-Site Assistance Teams. NSF Interdisciplinary research study on earthquake preparedness (0/50K)	NSF Continue Study (0/25K)	NSF Complete Study	
31-1(d) Possible way to reduce the developmental period for flood control projects is to increase COE survey and funding recommendation authority for flood projects beyond $1 million and increase annual limitation for such projects beyond $25 million.	Legislation is pending in Congress to extend the standing COE authority to $2 million. The program provides a statutory authority for the COE to conduct small flood control surveys and develop projects within the cost limitations.			
32-2 The flood mapping program (Corps of Engineers, National Oceanic and Atmospheric Administration, and U.S. Geological Survey) should be emphasized, with a capability to permit production of maps on the scale of one inch to 400 feet (1" = 400') for urban and urbanizing areas.	NOAA, USGS This is a reimbursable program funded by HUD. COE The COE flood plain mapping service is a funded program in response to local and Federal agency requests received. The program identified possible extent of flooding and can be used for planning purposes, as			NOAA Continue program - include other coastal regions - include improved analyses for tides and surges. COE Program is funded annually on the basis of requests received and cannot be projected realistically.

*Note: All program costs shown in parentheses are (personnel/$000)

ANALYSIS OF GEP FINDINGS VS FEDERAL PROGRAM INCREASES FY 1973-FY 1978

FINDING	FY 1973 PROGRAM INCREASES	FY 1974 PROGRAM INCREASES	FY 75-78 PROGRAM ESTIMATES*	REMARKS
	COE (cont'd.) well as community zoning but is not an agency flood warning program. HUD Land use planning studies.			
32-3 Small Watershed Programs of DOA were not adequately funded in past years but funding level for 1972 is adequate. Adequate funding of these programs should be continued, to enhance the beneficial effects on flood abatement as well as on the environment.	DOA Program will be continued with budget requests to meet known and anticipated requirements.			
32-4 Consideration should be given in staffing the River Forecast and Warning System as required to expand services to all geographical areas and to ensure that all River Forecast Center can give extended hours of service when necessary.		NOAA Increase Staff at Portland and Cincinnati RFCs to provide evening & weekend operations & begin implementation of improved hydrologic models (8/313K). Conduct dedicated research program on special hydrologic forecast problem in Alaska. (1/150K)	NOAA Establish full river forecast service at Utah, Nevada, Arizona and in parts of 3 other states in the inter-mountain area and complete staffing at all River Forecast Centers to provide evening and weekend forecast coverage, thus completing this service at all RFCs.	NOAA Program through FY 1978 completes action indicated in the finding.
32-5 The hydrologic data networks of the National Weather Service do not provide adequate coverage and rely mainly on manual reading and reporting of data. A complete network would be an expansion from 5,500 to 10,000 river and precipitation gages, with 2,500 gages automated through the NOAA Geostationary Operational Environmental Satellite (GOES) system and another 2,500 automated using ground communications.	NOAA Automate 175 river and rainfall stations for relay of data via either GOES or dial telephone (0/220K). Currently, 750 of the present 5,500 gages are equipped for telemetering of data by telephone or by radio.	NOAA Automate 175 river and rainfall stations using either satellite relay or direct dial telephone. Procure 10 snow-storage gage stations (1/505K).	NOAA Automate collection of hydrologic data from about 1,200 additional sites. Install about 1,500 river and rainfall stations. Initiate development of hydrologic instruments with improved reliability. Introduce new remote sensing techniques for evaluation of water content of snowpacks.	NOAA Program provides for automation of 1,550 stations for a total of 2,300. 3,000 additional stations are needed as well as the automation of approximately 2,200 more stations to satisfy the finding.

*Note: All program costs shown in parentheses are (personnel/$000)

ANALYSIS OF OEP FINDINGS VS FEDERAL PROGRAM INCREASES FY 1973-FY 1978

FINDING	FY 1973 PROGRAM INCREASES	FY 1974 PROGRAM INCREASES	FY 75-78 PROGRAM ESTIMATES*	REMARKS
	COE The COE incorporates stream gaging in certain of its river control projects principally in the Pacific NW and New England. The instrumentation is used for recording conditions and control decision-making procedures, and is also furnished to NWS for use in their forecasting programs. No program expansions are planned. Data obtained from DOA hydrologic stations are made available to National Weather Service for river and flood prediction.			COE No programmed expansion of stream gaging is planned. Data from any additional gage installation will be made available to NWS through established coordinating channels.
32-6 Computer service available to some River Forecast Centers is inadequate. Two centers are without computer service and some others must rely on early-generation equipment with limited core memory and slow speed.	NOAA Provide computer capability at RFCs at Hartford and Tulsa (0/70K).		NOAA Update computer capability so as to convert forecast operations at RFCs to the improved hydrologic forecast model. Strengthen supporting research in specific river forecasting problem areas and revise prediction models to reflect changes in streams and flows due to natural and man-made changes.	
	NSF Sponsor basic research to upgrade hydraulic and hydrologic models and to conduct land use planning studies (0/100K).	NSF Continue (0/70K).	NSF Continue.	
32-8 The flash flood prediction and warning program has a limited capability to provide technical assistance in establishing	NOAA Expand staff at 7 RFCs, Salt Lake City, Hartford, Tulsa, Ft. Worth, Kansas City, Portland,	NOAA Expand flash flood warning services beginning in those communities with the most	NOAA Expand the flash flood program to all states by [illegible]lishing about 200 alarm sy[illegible] and	NOAA About 1,250 more flash flood alarm systems will be needed at the rate of

*Note: All program costs shown in parentheses are (personnel/$000)

ANALYSIS OF OHF FINDINGS VS FEDERAL PROGRAM INCREASES FY 1973-FY 1978

FINDING	FY 1973 PROGRAM INCREASES	FY 1974 PROGRAM INCREASES	FY 75-78 PROGRAM ESTIMATES*	REMARKS
32-8 (cont'd.) local community systems and lacks qualified personnel in many Weather Service Offices to prepare general forecasts of flash floods.	NOAA (cont'd.) and Sacramento, at WSO San Juan and Honolulu, and at NWS Headquarters to support flash flood program (10/219). Install 10 flash flood alarms and procure 20 more (0/116).	NOAA (cont'd.) pressing need by providing proficiency training for hydrologic specialists to carry out the program, installing 20 alarm systems and more self-help prediction systems. Procure 25 more alarm systems (6/354K).	NOAA (cont'd.) providing 39 additional hydrologic specialists.	NOAA (cont'd.) about 60 per year, and about 20 more hydrologic specialists will be needed to install and service them.
32-9 Weather Radar surveillance, and associated radar facsimile service, for local Weather Service Offices in many areas prone to flash floods can be significantly improved. Consideration should be given to: Expanding the National Weather Service's radar network by some 25 radar stations and providing remote readout from selected Federal Aviation Administration radar facilities. Extending the National Weather Service's radar facsimile network (RAFAX) to local Weather Service Offices in areas vulnerable to flash floods and now without this service.	NOAA Take over operation of radar at Pensacola, Fla. from Navy (7/151K).	NOAA Augment national radar network by acquiring WSR-57 radars for southern Virginia and eastern Texas (0/420K). Obtain 18 modern radars to replace obsolete WW II surplus equipment and to fill gaps in the network (0/1300K). Extend RAWARC network to 31 additional offices and the National Facsimile system to 23 more offices to facilitate preparation and transmission of warnings (0/375K).	NOAA Complete installation and begin operation of east Texas and south Virginia WSR-57 radars acquired in FY 74. Add three WSR-57 radars in N.Y., N. Dak. and Nebr. Procure 48 additional and install and operate the 66 local use radars. Establish joint use (with FAA) radars at Denver and in Alaska. Complete implementation of digitized radar system at each of 56 WSR-57 sites. Extend direct radar support through remoting techniques with 29 additional remote transmitters and 54 recorders. Add 60 Instant Replay Devices to all Network Radars. Provide 28 video integrator processors.	
44-1 The first and perhaps most crucial means of life-protection from tornadoes is timely and accurate warning. Past technological applications have resulted in a decline in the loss of life; however, there are new technological opportunities that offer substantial improvement in tornado prediction and warning.	NSF Basic research to develop improved atmospheric models and to improve remote technology methods (0/230K) and engineering research (0/100K).	NSF Continue programs in modeling and remote technology (0/170K) and engineering research (0/300K). NOAA Develop automation of field operations and services for more effective application of manpower to warning preparation, especially during emergencies (0/400K).	NSF Continue. NOAA Complete AFOS with installations at 227 locations.	

*Note: All program costs shown in parentheses are (personnel/$000)

ANALYSIS OF OEP FINDINGS VS FEDERAL PROGRAM INCREASES FY 1973-FY 1978

FINDING	FY 1973 PROGRAM INCREASES	FY 1974 PROGRAM INCREASES	FY 75-78 PROGRAM ESTIMATES*	REMARKS
44-1 (a) An increased number and improved quality of radar installations would improve detection, intensity, and movement of severe storms, which is the basis for tornado prediction.	NOAA See program opposite finding 32-9 under River Floods. Obtain detailed wind measurements within severe storms by using Doppler radar techniques to improve understanding of storm processes (2/501K).	NOAA Continue development of Doppler radar applications (0/100K). Conduct research and development of operational systems to exploit recent breakthroughs in acoustic sounding and optical lidar techniques for remote measurement of vertical wind profiles and design an HF sea-scatter radar for remote mapping of wave height directional spectrum for sea waves. (0/650K).	NOAA In addition to program opposite par. 32-9 under River Floods, develop improved dynamic and statistical prediction models.	NOAA See program opposite finding 32-9 under River Floods.
44-1(b) The planned Geostationary Operational Environmental Satellite will improve early observations of severe storms developments and thereby enhance the forecasting of possible tornadoes.	NOAA Continue procurement of GOES A spacecraft (0/1,200K) and initiate procurement of launch vehicle (0/1,400K). Continue procurement of GOES command and data acquisition equipment (0/2,400K); complete staffing needs for support of one GOES operation (21/263K). Continue procurement of display equipment for use with SMS/GOES (0/270K); provide personnel to strengthen warnings staff to utilize SMS/GOES data (13/270K).	NOAA Complete GOES A spacecraft and initiate procurement of GOES B & C spacecraft (0/1537K); complete GOES A launch vehicle (0/1535K); fund GOES A launch service (0/1000K); GOES ground equipment (0/1823K); staff and equipment for field operations (109/1997K); command & data acquisition (33/503K); data processing (36/1210K); planning & implementation of systems (14/223K). ITOS sounding data & information from higher latitudes will supplement GOES data: Polar-orbiting spacecraft, launch vehicles, launch services, ground equipment (0/5722K); develop remote sensing techniques and apply data more effectively (12/[illegible]5K). Provide staff & equipment to utilize data from GOES & ITOS (14/970K).	NOAA Maintain a 2-GOES operational continuing monitoring system giving complete coverage over the U.S. (up to about 55° lat.) and adjacent waters. Highest priority needs include hurricane location and severe local storms and tornado detection. Procure SMS/GOES display equipment for 77 additional forecast offices and provide staff for operation and maintenance. Follow-up to Disaster Warning Satellite Study and development of the Disaster Warning Satellite to be coordinated with the DIDS system prototype installation by DCPA. DIDS and NWS are proposed for use in disseminating disaster warnings.	NOAA The 2-GOES system is expected to be operational beginning in FY 1974 and continuing thereafter. This satisfies finding.

*Note: All program costs shown in parentheses are (personnel/$000)

ANALYSIS OF OEP FINDINGS VS FEDERAL PROGRAM INCREASES FY 1973-FY 1978

FINDING	FY 1973 PROGRAM INCREASES	FY 1974 PROGRAM INCREASES	FY 75-78 PROGRAM ESTIMATES*	REMARKS
66-1 (c) Expansion of NOAA's communications facilities would improve tornado warning service: specifically, (1) the Weather Wire Service, which provides warning messages to the news media, and (2) the VHF-FM Radio Network, which provides continuous severe weather broadcasts. Also, additional DCPA National Warning System circuits, planned for installation in Weather Service Offices and communities, will provide interstate connections for speeding the warning process when tornadoes cross State boundaries.	NOAA Extend NOAA Weather Wire to 5 States and District of Columbia (6/240K).	NOAA Provide new NWWS service in 4 additional States and complete 5 other States now partially serviced (22/550K); augment & current VHF-FM systems and procure equipment for 7 additional stations (6/300K).	NOAA Complete remaining States with full NOAA Weather Wire Service. Continue implementation of VHF-FM throughout the U.S. by installation of approximately 119 additional stations.	NOAA Installations of VHF-FM stations at the rate of 20 per year will be needed for 5 years beyond FY 1978 to complete the program.
	DCPA Added 76 National Weather Service Stations to the DCPA National Warning Systems giving them a total of 225 Stations on the system. The program is funded through Department of Army. This increased FY 73 funds by $40K.	DCPA National Weather Service stations will be added to the National Warning System (NAWAS) where needed when determined by DCPA in consultation with DCPA Regions, the States and the National Weather Service Headquarters. In those areas where DIDS is in full operation, the use of that system may be effected to the extent advantageous.		
66-1 (d) Adoption of a low-cost national warning system, such as the Civil Defense Decision Information Distribution System (DIDS), including installation of home receivers, would be especially useful in tornado warning.	DCPA A related but seperately funded program ($100K in FY 72) recommended by OTP is underway in DCPA to develop low cost home receivers for the general public. (0/581K) A prototype of first low frequency radio distribution facility will be deployed at Edgewood, Md.	DCPA Continue engineering test and evaluation of DIDS.		
		NOAA See study of a Disaster Warning Satellite System under 66-1 (b).	NOAA Continue Disaster Warning Study. See finding 66-1 (b).	NOAA See finding 66-1 (b).

*Note: All program costs shown in parentheses are (personnel/$000)

ANALYSIS OF OEP FINDINGS VS FEDERAL PROGRAM INCREASES FY 1975-FY 1978

FINDING	FY 1975 PROGRAM INCREASES	FY 1976 PROGRAM INCREASES	FY 77-78 PROGRAM ESTIMATES*	REMARKS
44-1 (e) Alternative means for transmission of tornado information and independent emergency power sources are essential because of frequent disruptions during severe storms.		NOAA Install automatic telephone answering service at 60 largest cities not now served (0/100K); provide emergency power units at 4 WSO offices (0/100K).	NOAA Increase access by the public to all types of weather information through additional telephone announcement systems in about 60 cities and provide services to about 10 Cable TV systems. Equip additional offices and improve emergency power facilities at 40 offices and furnish 47 more offices with emergency radio communications. By FY 78 the emergency power program will be complete and communications program will be approximately 65% complete for key centers, forecast offices, and WSR-57 radar installations.	NOAA Telephone and CATV dissemination requirements will continue to evolve as population grows and urban areas develop. Install 8 additional sets of emergency radio equipment. This will complete the program for major centers, forecast offices and radar installations. This plan is now being revised and expanded to include all weather service offices with warning responsibilities.
44-3 The Federal Government has been helpful, but could improve its assistance programs for tornado preparedness by providing financial assistance and technical advice to the States, through NOAA, for the establishment of tornado preparedness training programs for local government officials and members of volunteer service organizations.		NOAA Assign 14 community preparedness specialists to 14 WSFOs to work with State civil defense and DCPA representatives; prepare information pamphlets, brochures, and other material for public information (14/520K)	NOAA Assign specialists to 38 additional offices.	
51-3 More exact prediction of a hurricane's course, landfall, and destructive potential is needed so that evacuation and emergency measures can be taken with greater confidence and executed with maximum thoroughness.	NOAA Operate ground systems to acquire information from GOES (3/127K). Staff to analyze and interpret GOES data for hurricane warnings (20/246K). See related GOES program in Tornadoes and Windstorms.	NOAA Procure and start installation of AMRS (airborne automated data acquisition system) on RFF aircraft to provide backup support to DOD weather reconnaissance aircraft (0/3600K). Procure one modern four-engine	NOAA Procure three AWRP for installation of Air Force aircraft to augment hurricane detection, tracking, and warning capability. Complete the instrumentation of NOAA aircraft. Develop improved dynamical	NOAA Base program in hurricane research will be continued

*Note: All program costs shown in parentheses are (personnel/$000)

ANALYSIS OF OEP FINDINGS VS FEDERAL PROGRAM INCREASES FY 1973-FY 1978

FINDING	FY 1973 PROGRAM INCREASES	FY 1974 PROGRAM INCREASES	FY 75-78 PROGRAM ESTIMATES*	REMARKS
	NOAA (cont'd.) 44-1 (b). Increase capability for testing and evaluating new or modified numerical models prior to operational use. This should give forecasters improved guidance. The National Meteorological Center is working with the small-scale storm features. Work will also continue on the limited fine-mesh model, paving the way for better resolution of weather patterns when the next generation computer becomes available. It is anticipated that significant improvements in the model products will be achieved as a direct result of satellite sounding data now available for operational use from NOAA-2 (0/800K).	NOAA (cont'd.) aircraft to replace one of three obsolete RFF aircraft (0/5165K). See related GOES program in Tornadoes and Windstorms 44-1 (b). Continue NMC development of numerical models (0/1230K).	NOAA (cont'd.) techniques for predicting hurricane movement and behavior. See also GOES display equipment program in 44-1 (b).	
36-3 Much of today's capability to forecast a hurricane event fails to be translated into effective reaction simply because the specific vulnerabilities and resources of local areas are not adequately assessed. The program directed by NOAA for elevation mapping should be furthered, and cooperative arrangements, with appropriate incentives and assistance, should be made with State jurisdictions to speed the effort.	NOAA Base program included in Coastal Mapping and Boundary Surveys is funded at a level of 100K. No increase planned for FY 1973.	NOAA Continue base program for construction of hurricane evacuation charts at rate of 12 to 15 charts per year. No increase planned for FY 1974.	NOAA Continue base program for construction of hurricane evacuation charts. Increase rate to 36 charts per year. Program goal is to construct 200 charts covering Gulf and East Coast flood prone areas.	NOAA Goal is completion of basic chart program for Gulf and East Coasts in 5 years. Continue at same level for other areas and for chart updating.

*Note: All program costs shown in parentheses are (personnel/$000)

ANALYSIS OF OEP FINDINGS VS FEDERAL PROGRAM INCREASES FY 1973-FY 1978

FINDING	FY 1973 PROGRAM INCREASES	FY 1974 PROGRAM INCREASES	FY 75-78 PROGRAM ESTIMATES*	REMARKS
54-5 Public information programs can and should be improved in significant measure by existing public and private agencies with facts already known.				NOAA See finding 44-3 dealing with programs in community preparedness.
54-6 In view of the enormous benefits that would come from modification or neutralization of hurricanes, research in the field of weather modification may have a very favorable cost-benefit potential. The present state of the art for hurricane seeding indicates a 10 percent reduction of hurricane damage may be achievable. Federal projects in weather modification can be reinforced. NOAA and its partners in Project Stormfury should seek to develop a seeding technology and associated mathematical models of hurricanes as a preliminary to an operational capability.	NOAA During this period and through FY 78 NOAA will conduct theoretical studies and field experiments to develop the technology for moderating the damaging winds of hurricanes; determine the extent of modification of winds on the storm's motion, storm surge, and storm precipitation; and establish an operational capability within NOAA for hurricane moderation.		NOAA NOAA plans to stand down Stormfury until it has the resources to move to the Pacific in FY 1976, where 3 times as many storms eligible for seeding can be expected each year. The lack of suitable storms to be experimented on has been the chief delay in getting results from Stormfury. Beginning in FY 77, reimburse Air Force to assist in Stormfury operations.	NOAA See finding 131-1 dealing with broad programs in weather modification. The planned withdrawal of DOD from Stormfury in FY 1974 has caused NOAA some planning problems. In particular, the planned move to the Pacific in FY 1976 will depend critically on the ability of NOAA to build up its aircraft support fleet, RFF.
54-8 Despite substantial progress, there is still need for better understanding of the causes and mechanics of hurricanes. NOAA's hurricane research programs and operations units are sound, but further scientific investigation is needed to develop improvements in prediction, warning, and protection. These will require equipment for data collection, real-time relay and processing, and computer analysis on a larger scale.	NSF Basic Research on hurricane mechanisms (130K).	NOAA See item on remote sensing under 44-1 (a). Procure and install 6 tide and wave gages. NSF Continue research (70K).	NOAA Procure and install 18 automatic tide and wave gages and recording equipment. Extend automated prediction model for storm surge warnings to additional points along the east coast. NSF Continue research.	NOAA Continuing research will be needed to meet this finding. Add 6 automated tide and wave gages to complete the program.

*Note: All program costs shown in parentheses are (personnel/$000)

ANALYSIS OF OEP FINDINGS VS FEDERAL PROGRAM INCREASES FY 1973-FY 1978

FINDING	FY 1973 PROGRAM INCREASES	FY 1974 PROGRAM INCREASES	FY 75-78 PROGRAM ESTIMATES*	REMARKS
71-7 The number of fires, from all causes, can be reduced or contained by an improvement in the present prediction and warning procedures. A program which offers a potential for improvement is:				
71-7 (a) Completion by the Forest Service of the new National Fire Danger Rating System, with the dissemination and use of standardized procedures by all field agencies. Development of an "objective risk" rating system which would provide more accurate information of fire conditions in selected fire danger rating areas.	DOA Complete the development of Fire Danger Rating Systems. Implement the System on 100 National Forests. Begin development of automatic fire danger rating station and fire weather station (190K).	DOA Continued implementation of the new system (50K).	DOA Refine the system through evaluation and review. Complete implementation in all public lands.	
	NSF Research on fire mechanisms and smoke effects (100K).	NSF Continue research (200K).	NSF Continue research.	
71-7 (b) Completion of the NOAA "Federal Plan for a National Fire Weather Service" to provide improved and expanded fire weather service for all fire control agencies.			NOAA Provide specially trained meteorologists until 39 National Weather Service Offices are staffed to meet the needs for fire weather services.	NOAA The program outlined completes the action required to satisfy the finding.
86-1 The greatest potential for reducing the loss of life and property from earthquakes lies in restricting the use of land in high-risk areas and in imposing appropriate structural-engineering and materials standards upon both new and existing buildings.	NSF Research on Engineering Design Development of Applications and Information and other related research (3100K).	NSF Continue research (800K).	NSF Continue research.	

*Note: All program costs shown in parentheses are (personnel/$000)

ANALYSIS OF OEP FINDINGS VS FEDERAL PROGRAM INCREASES FY 1973-FY 1978

FINDING	FY 1973 PROGRAM INCREASES	FY 1974 PROGRAM INCREASES	FY 75-78 PROGRAM ESTIMATES*	REMARKS
85-2 The greater use of instruments is essential to increasing knowledge, to providing risk maps, and to developing a theory of prediction--and perhaps control--of earthquakes.			NOAA Complete conversion of Western Earthquake Information Exchange System. Install high-sensitivity long period equipment at 15 observatories; very low gain recorders at 3 worldwide standardized seismic network stations; install and operate approximately 100 stations to complete observatory network for detecting earthquakes of magnitude 3+; observatory network of 145 stations completed by FY 1978.	
	USGS Install seismographs, tiltmeters, and magnetometers in selected regions of important earthquake activity; expand trilateration survey network for crustal deformation studies in southern California and other tectonically active areas (fundings shown under 85-3, 4, and 5).	USGS Install additional instrumentation and expand crustal deformation studies (about 300K).	USGS Install or redeploy instrumentation to examine in detail special problem areas.	
85-3 The development of seismic risk maps is an essential first step in hazard reduction and preparedness planning.	NOAA Completed a Study of Earthquake Losses in the San Francisco Bay Area to support planning for earthquake disaster relief and recovery operations. Study and assess potential damages from earthquakes.			
	USGS Gather basic geologic and seismological data for detailed seismic risk analysis including active-fault location,	USGS Acquire further geologic and seismological data. Translate results into maps suitable for risk analysis (850K).	USGS Continue data acquisition with increasing emphasis on presentation of results for planning purposes.	

*Note: All program costs shown in parentheses are (personnel/$000)

ANALYSIS OF OEP FINDINGS VS FEDERAL PROGRAM INCREASES FY 1973-FY 1978

FINDING	FY 1973 PROGRAM INCREASES	FY 1974 PROGRAM INCREASES	FY 75-78 PROGRAM ESTIMATES*	REMARKS
	USGS (cont'd.) recurrence intervals for fault movement, structural setting, ground motion variation, seismicity, ground failure, and tectonic elevation changes (2600K).			
85-6 At this time, the capability does not exist to predict the timing of earthquakes with any significant degree of certainty.	USGS Develop the physical understanding and the instrumental means required for forecasting the time, place, and magnitudes of earthquakes, and to implement and evaluate an experimental earthquake prediction system in central California; develop the historical and geological background for estimating earthquake probability and recurrence characteristics (1000K). NSF Research on Earthquake Prediction.	USGS Further implement earthquake prediction program to complete instrumentation systems (1000K) NSF Continue research.	USGS Evaluate results of laboratory and field studies; undertake intensive investigations of earthquake precursors. NSF Continue research.	NOAA Continuing research will be needed to satisfy this finding.
85-5 There is a possibility that earthquakes can be controlled.	USGS Evaluate the feasibility of controlling the release of stress in the upper crust of the earth by means of theoretical analysis, laboratory experiment (290K).	USGS Undertake a small-scale field experiment in a rock quarry (600K).	USGS Drill deep holes into active fault zones to sample materials and measure rock properties.	

*Note: All program costs shown in parentheses are (personnel/$000)

ANALYSIS OF OEP FINDINGS VS FEDERAL PROGRAM INCREASES FY 1973-FY 1978

FINDING	FY 1973 PROGRAM INCREASES	FY 1974 PROGRAM INCREASES	FY 75-78 PROGRAM ESTIMATES*	REMARKS
85-6 The level of earthquake disaster planning in most areas of high seismic risk is not satisfactory.	USGS Develop in collaboration with other government agencies, administrative, economic, and social techniques by which the earth sciences may have direct impact on reducing the hazards of earthquakes (0/100K).	USGS Continue collaboration (0/100K)	USGS Increase efforts to incorporate results of scientific studies in planning for disasters.	
	NSF Research on Hazards Identification (400K).	NSF Continue research (200K).	NSF Continue research.	
85-8 Public awareness of the threat posed by earthquakes is essential to success in preparing for them and moderating their destructive effects.	NOAA Items under 85-2 also applicable here.		NOAA Improvement to NEIC computer plotting and communications system to enable faster dissemination of information to the public (0/90K).	
WO-3 Consideration should be given to expanding the landslide program of the U.S. Geological Survey, in conjunction with other Federal and State agencies.	USGS Identify, characterize, and map areas of potential landslide; develop a basic understanding of the physical behavior of rocks and soils under conditions associated with landslides (work carried out under Earthquake Hazards Reduction program).	USGS Continue landslide studies.	USGS Continue landslide studies.	
	DOA Research on avalanche prediction technology will be expanded.	DOA Installation of new snow gage for test and evaluation.	DOA Complete test and evaluation of new gage and prediction techniques. Implement routine warnings program.	

*Note: All program costs shown in parentheses are (personnel/$000)

ANALYSIS OF OEP FINDINGS VS FEDERAL PROGRAM INCREASES FY 1973-FY 1978

FINDING	FY 1973 PROGRAM INCREASES	FY 1974 PROGRAM INCREASES	FY 75-78 PROGRAM ESTIMATES*	REMARKS
101-1 Accurate prediction of tsunami wave height at any given point in the Pacific Ocean is not feasible at present. There is a need to reduce the time between the occurrence of a tsunami-generating earthquake and the warning of vulnerable areas.			NOAA Improve timeliness, accuracy and resolution of tsunami warnings by providing interface on seismic and tide stations for relay of data to National Tsunami Warning Center on a near real-time basis using GOES and complete automatic telemetry installations at all seismic and tide stations. Provide display and communications control equipment for GOES data at NTWC and install dedicated data transmission line between Wallops and Honolulu, and new tide and seismic stations. Continue studies of wave shoreline interaction, wave propagation, and methods of measuring the tsunami effects in the open ocean and real-time and computing forward to shoreline effects.	NOAA Continuing research is required to meet this finding.
	NSF Tsunami Research (100K).	NSF Continue research (250K).	NSF Continue research.	
106-1 With the exception of those on the Hawaiian Islands, most volcanoes in the United States are inactive, and thus pose only a relatively latent threat to the Pacific Northwest.	USGS Install earthquake detectors, tiltmeters, and magnetometers on four volcanoes in the Cascade Range for volcano surveillance (0/170K NASA transfer funds); conduct infrared monitoring by satellite of Hawaii (0/70K); prepare volcano hazards map of Hawaii (0/30K).	USGS Continue volcano monitoring.	USGS Continue volcano monitoring.	

*Note: All program costs shown in parentheses are (personnel/$000)

ANALYSIS OF OEP FINDINGS VS FEDERAL PROGRAM INCREASES FY 1973-FY 1978

FINDING	FY 1973 PROGRAM INCREASES	FY 1974 PROGRAM INCREASES	FY 75-78 PROGRAM ESTIMATES*	REMARKS
114-1 The Fruit-Frost Weather Service and the Agricultural Weather Service have provided satisfactory cold weather prediction and warning information to selected areas of the agricultural community; however, this service is not provided countrywide. Completion of the "Plan for an Improved Agricultural Weather Service" will provide more effective frost and freeze protection information to all areas of the United States, but will require additional funding for completion.			NOAA Complete implementation of the Federal Plan for a National Agricultural Weather Service in annual increments FY 1976 through FY 1977. Provide service in Arizona, Ohio, New York, Nebraska, Montana, North Carolina, Wyoming, Iowa, Illinois, California, Wisconsin, Minnesota and Massachusetts, and expand partial service to full service in Texas, Mississippi, Michigan, Tennessee and Georgia.	
122-2 Droughts do not pose an immediate danger to life and property, because they are slow in reaching disaster status; however, there can be a serious economic impact which develops over a prolonged period in the drought-stricken area.	NSF Studies of long term climatology effects of droughts (50K).	NSF Continue studies (50K).	NSF Continue studies.	
122-3 Weather modification holds promise of increasing precipitation during dry seasons and reducing the effects of cyclic droughts.	NOAA Present NOAA program of drought analyses will be continued. Base 2/70K.	NOAA Accelerate tropical cumulus modification experiment to assist prediction of precipitation potential of convective clouds (0/123K).		NOAA See Weather Modification Findings 151-1, 151-4. OMB has directed that NOAA restrict its precipitation enhancement work to the Florida Cumulus Program and general research on cloud and precipitation physics and the modification of severe storms.

*Note: All program costs shown in parentheses are
[illegible]

ANALYSIS OF OEP FINDINGS VS FEDERAL PROGRAM INCREASES FY 1973-FY 1978

FINDING	FY 1973 PROGRAM INCREASES	FY 1974 PROGRAM INCREASES	FY 75-78 PROGRAM ESTIMATES*	REMARKS
122-3 (cont'd.)	DOI Drought relief cloud seeding under emergency conditions, initiated in 1971, and support of developing statewide weather modification programs will continue as requested.			
151-1 Experiments in weather modification indicate many potential uses, including the mitigation of disasters caused by weather phenomena. There is a need for further examination of the Federal role in weather modification activities.			NOAA NOAA will gain a more complete understanding of the physical processes underlying severe local storms, including windstorms, flash floods, lightning and tornadoes; develop approaches to modification of severe storms; and carry out field tests of promising techniques.	NOAA NOAA responsibility for social, economic, and legal studies are being transferred to the National Science Foundation by agreement with the Office of Management and Budget.
	NSF Research on Weather Modification including NSF support with NCAR for the National Hail Research Experiment (2,000K).	NSF Continue research (400K).	NSF Continue research.	
	DOA Development of computer model of thunderstorm including electrical processes. Design of evaluation program for operational cloud seeding program (1/30K).	DOA Continuation of modeling and research on electrical processes in convective storms. Participation in operational program in Alaska.	DOA Develop and implement operational program of lightning suppression. Analyze and use results of operational program evaluation in design of operational system.	
151-2 & 151-3 Moreover, the interstate and international aspects of most such activities suggest a strong Federal role in the management, licensing, and control of weather modification operations should be exercised by a single existing agency in order to	NOAA Establish Weather Modification Activity Reporting Office under authority of PL 92-205, 85 stat. 735 (5/200K).		NOAA A bill is under consideration in the executive branch that would enact Federal regulatory and licensing authority related to weather modification activities, and would assign this responsibility to NOAA.	

*Note: All program costs shown in parentheses are (personnel/$000)

ANALYSIS OF GEP FINDINGS VS FEDERAL PROGRAM INCREASES FY 1973-FY 1978

FINDING	FY 1973 PROGRAM INCREASES	FY 1976 PROGRAM INCREASES	FY 75-78 PROGRAM ESTIMATES*	REMARKS
151-2 & 151-3 (cont'd.) ensure effectiveness and economy. This agency would implement provisions related to licenses, permits, information gathering, and decision making. The Department of Commerce has extensive technical knowledge and experience in the management and operation of weather modification programs and therefore could be assigned this function.				
151-4 There is a continuing need for coordination and integration of the activities of the Federal agencies engaged in weather modification efforts.	NOAA NOAA continues active participation in the National Hail Research Experiment (NHRE), an interagency program for which the National Science Foundation is lead agency. FY 73 work and beyond will be strictly on a reimbursable basis.		NOAA The NHRE program will be participitated in on a reimbursable basis until successfully completed; the program may continue through FY 78.	NOAA OMB has directed NOAA to drop work on hail suppression except on a reimbursable basis.
159-1 (c) Incorporation of disaster research requirements in the program of "Research Applied to National Needs" by the National Science Foundation should encourage and achieve improvements in disaster research applications to existing problems.	NSF Disaster related studies (50K).	NSF Continue studies.	NSF Continue studies.	

*Note: All program costs shown in parentheses are (personnel/$000)

B. SUMMARY OF AGENCY COSTS

Table A summarizes the FY 1974 program funding increases by function for each agency. In this table, funds for research are included in the totals for the functions to which the research applies. Tables B, C, D, E, and F give further details on the various items included within each function for which FY 1974 increases are requested.

PROGRAM INCREASES BY AGENCY
(in thousands of dollars)
FISCAL YEAR 1974

	NOAA	DOA	DOI	DOD	NSF	TOTAL FY 1974 INCREASES	TOTAL FY 1973 PROGRAM
WARNING SYSTEM							
MONITORING	11,717	150	300		110	12,277	29,402
WARNING PREPARATION	3,562		1,000		370	4,932	26,057
WARNING DISSEMINATION	1,275		100	700		2,075	20,744
MODIFICATION AND CONTROL	8,888		-2,750		200	6,338	16,877
COMMUNITY PREPAREDNESS							
ASSESSMENTS			850	471	2,770	4,091	24,750
PLANNING	520			1,614	310	2,444	18,025
PROGRAM MANAGEMENT				2,728		2,728	41,885
TOTAL	25,962	150	-500	5,513	3,760	34,885	205,013

NOTE: Research funds for FY 1973 - $27,273 and FY 1974 - $4,885 are included in the table. NOAA figures do not include cost of ITOS Satellite Program

Table A

MONITORING

FY 1974 INCREASES
(In thousands of dollars)

	NOAA	DOA	DOI	NSF	TOTAL
o GEOSTATIONARY SATELLITES	7892				
o RADAR	1920				
o HYDROLOGIC NETWORK AUTOMATION AND EXPANSION	505				
o FLASH FLOOD ALARMS	125				
o SOLID EARTH MONITORING NETWORKS			300		
o FIRE DANGER RATING SYSTEM		100			
o REMOTE SENSING RESEARCH	650				
o TORNADO DETECTION RESEARCH				110	
o FIRE DANGER RATING SYSTEM RESEARCH		50			
o SATELLITE SENSOR DEVELOPMENT	625				
TOTAL FY 1974 INCREASES	11,717	150	300	110	12,277
TOTAL FY 1973 EXPENDITURES (ITOS SATELLITE PROGRAM NOT INCLUDED)					29,402

Table B

WARNING PREPARATION

	FY 1974 INCREASES (In thousands of dollars)			
	NOAA	**DOI**	**NSF**	**TOTAL**
o COMPUTER IV	1,250			
o SATELLITE DATA DISPLAY EQUIPMENT	970			
o FLASH FLOOD SPECIALISTS	229			
o COMPLETION OF NAFAX	150			
o EARTHQUAKE PREDICTION		1,000		
o IMPROVE RFC OPERATIONS	463			
o TORNADO MODELING AND PREDICTION RESEARCH	100		150	
o AUTOMATION OF FIELD OPERATING SERVICES (AFOS)	400			
o EARTHQUAKE PREDICTION RESEARCH			150	
o HURRICANE MODELING AND PREDICTION RESEARCH			70	
TOTAL FY 1974 INCREASES	3,562	1,000	370	4,932
TOTAL FY 1973 EXPENDITURES				26,057

Table C

WARNING DISSEMINATION

	FY 1974 INCREASES (In thousands of dollars)			
	NOAA	DOD	DOI	TOTAL
o NOAA WEATHER WIRE SERVICE	550			
o VHF/FM RADIO	300			
o AUTOMATIC TELEPHONE	100			
o RAWARC EXPANSION AND MODERNIZATION	225			
o EMERGENCY POWER AND COMMUNICATIONS	100			
o NAWAS		628		
o DECISION INFORMATION DISTRIBUTION SYSTEM		-181		
o PUBLIC RESPONSE		228	100	
o DISSEMINATION AND PUBLIC RESPONSE RESEARCH		25		
TOTAL FY 1974 INCREASES	1,275	700	100	2,075
TOTAL FY 1973 EXPENDITURES				20,744

Table D

MODIFICATION AND CONTROL

FY 1974 INCREASES
(In thousands of dollars)

	NOAA	NSF	DOI	TOTAL
o MODIFICATION OF CONVECTIVE CLOUDS	123			
o RFF MODERNIZATION	8,765			
o PRECIPITATION MANAGEMENT			-3,350	
o SEVERE STORM RESEARCH		200		
o EARTHQUAKE CONTROL RESEARCH			600	
TOTAL FY 1974 INCREASES	8,888	200	-2,750	6,338
TOTAL FY 1973 EXPENDITURES				16,877

Table E

COMMUNITY PREPAREDNESS

FY 1974 INCREASES
(In thousands of dollars)

	NOAA	NSF	DOI	DOD	TOTAL
o COMMUNITY ON-SITE ASSISTANCE				5,338	
o PLANNING AND ASSESSMENT RESEARCH				-525	
o COMMUNITY PREPAREDNESS SPECIALISTS	520				
o FLASH FLOOD SPECIALISTS	(WP)*				
o RISK MAPPING AND HAZARD ASSESSMENT PROGRAMS			850		
o EARTHQUAKE ENGINEERING RESEARCH		2,650			
o MAXIMUM FLOOD AND RUNOFF RESEARCH		70			
o TORNADO WIND EFFECTS ON STRUCTURES RESEARCH		110			
o FIRE MECHANISMS RESEARCH		200			
o LONG-TERM CLIMATE CHANGE RESEARCH		50			
TOTAL FY 1974 INCREASES	520	3,080	850	4,813	9,263
TOTAL FY 1973 EXPENDITURES					84,660

Table F

* Included under WARNING PREPARATION

C. DESCRIPTION OF PROGRAM BENEFITS

Loss of life and property damage could not be completely eliminated even with a perfect warning system. Nevertheless, satisfaction of some of the needs identified by the major findings of recent reports on the present natural disaster warning systems and on community preparedness activities could provide more lead-time for protective actions, more accurate warning information, dissemination of more timely warnings to more people, and increased responsiveness of the general public and of decision makers in many disaster-sensitive activities. These would be reflected in reductions in suffering and loss of life, in property damage, in disruptions to the production of goods and services, and in delays in restoring conditions to near-normal after the disaster. Objective quantification of all of the resulting benefits is impracticable. In a 1972 analysis, "Protection from Natural Disasters - Program for the 70's", losses from natural disasters were estimated to be on the order of $10 billion annually and increasing. Reduction of these losses by 10-15% appears feasible through implementation of this Plan. A discussion of specific benefits for various types of natural disasters follows.

ENVIRONMENTAL MONITORING

Improved monitoring for early detection, and prompt collection of the observational data, are basic to a more effective disaster warning system. These increase the lead time for taking appropriate actions by making possible the earlier preparation of warnings. Major planned actions include automation of meteorological, river and rainfall stations; expansion of the national radar network and increase in the number of radars for local use, especially near population centers; and use of the proposed new GOES data collection capability for quickly gathering data, especially from remote locations.

Additional radars will add to the present capability to identify and track severe local storms, including tornadoes, and to detect areas of heavy rainfall associated with flash floods. Radar observations play an important part in the issuance of local warnings for the protection of life and property. Digitizing and processing of radar data by computer will greatly expand the effective utilization of the vast quantity of radar data now reported manually.

Programs to modernize and improve reconnaissance capabilities will provide more accurate fixes of hurricane centers and more accurate and timely data on storm structures and intensity. This will improve the accuracy of both analyses and forecasts and contribute to research on improved techniques.

Timely and reliable collection of observations from current reporting stations and from automated stations to be installed in data sparse areas in and immediately adjacent to the United States will improve the quality of the analyses and forecasts and contribute significantly to improving the timeliness of warnings of short-lived phenomena such as flash floods, which can not yet be reliably predicted. Applications of near-continuous satellite observations will improve the timeliness and accuracy of severe storm warnings.

WARNING PREPARATION

Hurricanes and Storm Surges

On the average, two hurricanes strike the United States each year killing an average of 62 persons and causing hundreds of millions of dollars in property damage. Endangered persons can be evacuated, and much can be done to protect property before a hurricane strikes. However, this depends on whether the public has confidence in the warnings and whether communities and individuals are prepared to take the necessary precautionary measures. In recent years the forecast error in 24-hour movement of the hurricane center has averaged 115 miles. This still results in the alerting of large areas. This "overwarning" results in some disregard of the warnings and in unnecessary expenditures and economic loss as people prepare for the hurricane; for example, by boarding-up windows. Presently, nearly two million people are included in the area covered by the "average" hurricane warning along the U.S. coast.

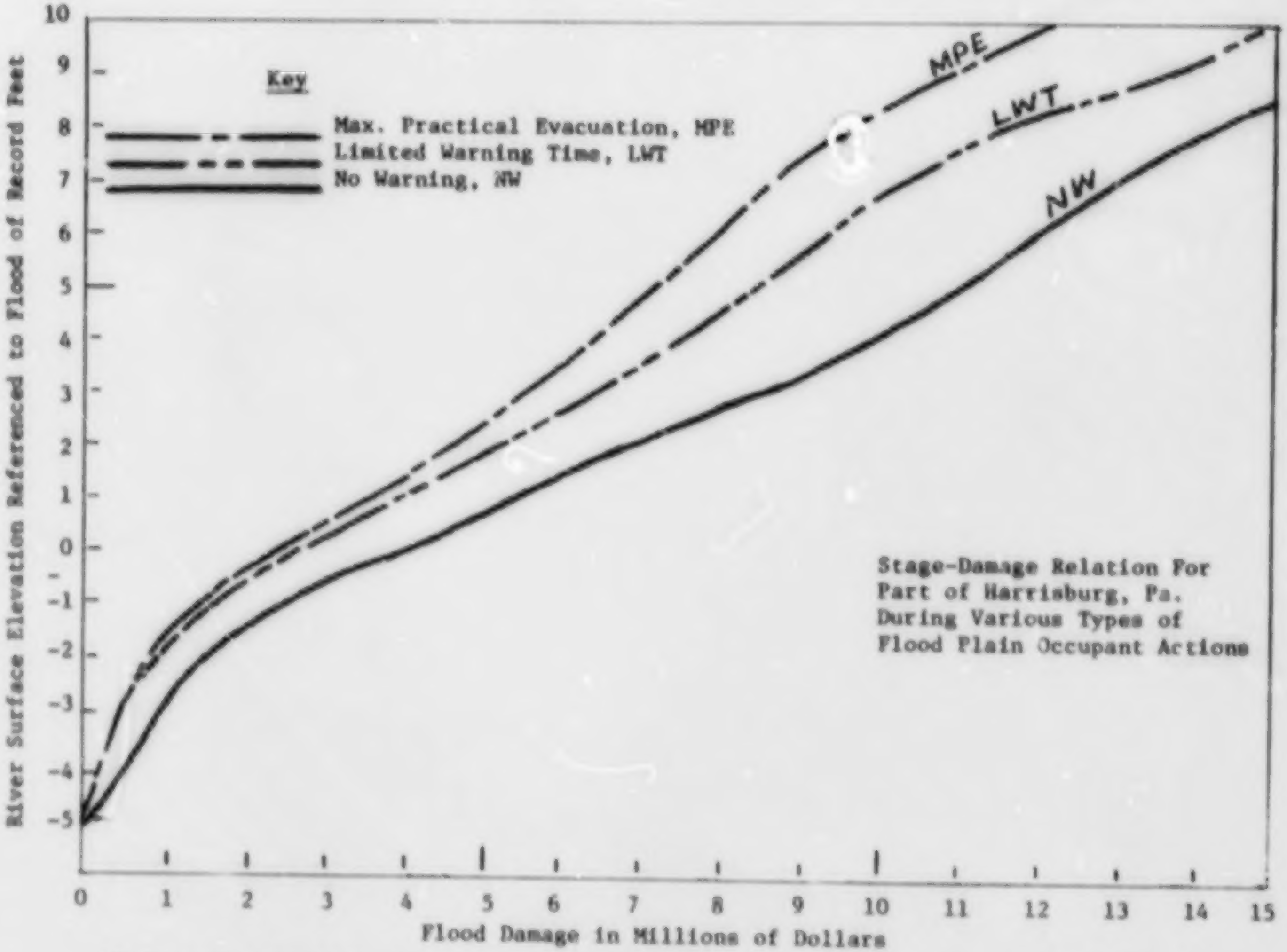
Development of better numerical forecasting models and automated data handling and display systems for real-time processing of data from hurricane reconnaissance aircraft and satellites should reduce the 24-hour forecast error. An average forecast error of not more than 75 miles appears to be a realistic goal. With more exact predictions of a hurricane's course, land fall, maximum storm surge heights and destructive potential will come greater public confidence, and community and individual emergency measures will be undertaken with less reservation and executed with greater efficiency and thoroughness. Fulfillment of all requested programs should reduce the number of people unnecessarily warned by 25 to 50 percent, the hurricane death total by 50 percent, and property damage by 25 percent.

Tornadoes and Severe Local Storms

Tornadoes which average 659 annually also cause hundreds of millions of dollars in property damage and kill an average of 114 persons. Because tornadoes develop rapidly, have a short duration, and are difficult to forecast, and because they are very destructive, neither the evacuation of warning areas nor the building of tornado proof homes is a practical means for reducing the damage and deaths they cause.

Planned operational and research programs are expected to lead to the development of a means of uniquely identifying and tracking tornadoes by radar or other instrumentation to improve the accuracy of warnings and more accurate forecasting techniques to reduce the size of tornado watch areas from the present average of 27,000 square miles.

Reduction of the size of tornado watch areas will correspondingly reduce the number of people unnecessarily warned. Similarly, the effectiveness



Stage-Damage Relation For
Part of Harrisburg, Pa.
During Various Types of
Flood Plain Occupant Actions

(Reference: Benefit Evaluation of a Flood Warning System to Urban Residences in the Susquehanna River Basin, by Harold J. Day, Associate Professor, Department of Civil Engineering, Carnegie-Mellon University, Pittsburgh, Pa.)

with which tornadoes are detected by spotters or uniquely identified by radar or other instrumentation, and the degree to which communities and individuals are prepared to react promptly and logically to warnings, will correspondingly reduce the annual death total from tornadoes.

Procurement of single sideband emergency communications units and power generators will help NWS offices to continue to collect data, operate equipment such as radars and disseminate severe weather information when commercial communications and power facilities are disrupted, thereby assuring the continued flow of warning information.

Severe Winter Storms

An average of one to two severe winter storms impact the United States each month from November through March. The average annual death toll is 88. While property damage may not be as great as in some hurricanes and tornadoes, accumulated economic losses can be enormous as large areas, including one or more metropolitan areas, are paralyzed by heavy snow or ice storms. All transportation modes are restricted, public utilities become overloaded, communications are disrupted, and public safety and law enforcement capabilities become overtaxed. Lost productivity associated with transportation tie-ups in only one metropolitan area can be quite significant.

Early and accurate warning information can be useful for alerting public officials, snow plow crews, and power line and communication line repairmen, all of whom can use warning information to help prevent a complete paralysis of the affected area.

Warnings are especially useful to agricultural interests, particularly stockmen, who must take protective measures for farm animals.

River and Flash Floods

Approximately 10 million people in flood plains and 36 million in urban areas are affected directly or indirectly by flood events. In the 1972 Hurricane Agnes floods 122 lives were lost and property damage totaled $3.5 billion. Annual national flood damages were estimated at one billion dollars per year by House Document 465 in 1966. Inflation, plus additional construction in the flood plains, raised this average figure to $1.5 billion to $2 billion by 1971 as shown in the Disaster Preparedness report to Congress prepared by OEP in compliance with PL 91-606 (January 1972).

The benefit-cost ratio from the river and flood warning program has been consistently estimated to be 15 to 1 or better over many years. In Operation Foresight, 1969, estimated savings were $230,000,000 according to the Corps of Engineers. Such large savings are unique but indicative of the savings that can accrue by use of a timely warning service. A recent study by Dr. Harold J. Day confirms this view. This is illustrated in the accompanying chart.

The flash-flood warning program was formalized in states along the East Coast in Fiscal Year 1971 and is geared to warning times that are short. The program is primarily aimed at saving lives, although it is often possible to save valuable and easily movable property.

Earthquakes

The occurrence of a great earthquake such as the 1964 Alaskan or 1906 San Francisco earthquakes in a heavily populated region of the U.S., represents the greatest single natural disaster that could occur. Some of this Nation's leading earthquake experts feel that deaths in the thousands and damage in the $20 to $50 billion range could result. They feel that the risks are great for such earthquakes within the next 10 to 30 years especially along the San Andreas Fault.

Although warnings are not now feasible, the potential devastation could be substantially reduced through vulnerability studies and consideration of earthquake risk in land use planning, and through development of information for the establishment of building codes to improve the earthquake damage resistance of structures. The application of risk maps, data on the response of structures to earthquakes, and damage loss estimates produced by engineering seismology programs will contribute to cost-effective land use planning for urban development, proper design of new structures, and strengthening of unsafe existing structures.

Success in the development of earthquake prediction technology could lead to many steps to protect the public. For example, water levels in critical reservoirs could be lowered; public utilities could be put on alert to contend with ruptured water and gas mains, fallen wires and other threats; particularly hazardous buildings could be evacuated.

Tsunamis

In the Tsunami Warning System automation of observations and speed-up of communications should lead to the issuance of a tsunami watch in less than 30 minutes after an earthquake anywhere in the Pacific and to the detection of a tsunami within 1 to 2 hours after its generation. This will permit earlier issuance of warnings and earlier protective actions by the general public.

Fire Weather

According to estimates from the Department of Agriculture, Forest Service, the value of NWS fire weather forecasting and warnings to the success of their fire suppression activities and related costs is placed at better than a 3:1 benefit/cost ratio. In addition, when the value of the substantive reduction in acreage burned because of weather support is added, the above ratio increases dramatically.

A net average savings of around 30 million dollars has been estimated if the National Fire Weather Service Plan is expanded. This would also reduce the loss of life and fire danger to communities, increase the national supply of timber while maintaining and improving the forest environment, and reduce erosion damages and the incidence of floods while lessening the threat of serious smoke pollution in nearby population centers.

WARNING DISSEMINATION

Improvement in the early availability of weather warning information to more people through extension of current dissemination capabilities and development of new systems will be a major factor in providing increased benefits through natural disaster warnings.

NWWS will be implemented completely or in part in 30 states by the end of Fiscal Year 1973. Expansion to the remaining states in the conterminous U.S. would increase the access of millions of people to warning services via the mass media.

Future use of cable television systems, some of which are capable of devoting one entire channel to the display of the latest weather information including watches and warnings, will expand the continuous availability of such warning information to a growing audience that now includes millions of viewers.

The establishment of VHF-FM radio continuous weather forecast facilities including tone alert capabilities will increase the portion of the public to which this direct "on demand" dissemination is available from about 35% to 82% in 1978.

The planned implementation of automatic recorded announcements via telephone will increase the capability to provide tailored forecasts and warnings on a "demand" basis from 40% of the population in 1972 to 90% in 1977.

The Decision Information Distribution System (DIDS), if fully implemented, could provide up to 97% geographical coverage in the conterminous United States for voice messages.

COMMUNITY PREPAREDNESS

Natural disasters cause numerous deaths and large economic losses each year. However, their impact can be greatly mitigated by comprehensive preparedness planning at the State and community levels and by appropriate training and public education programs.

Responsible authorities must have action plans for making prompt decisions on the basis of warning messages received and for putting these decisions into action; also, the warning channels and messages must be understood and used if benefits are to be derived.

Responsible authorities can also mitigate losses through the use of vulnerability assessment information in community planning: for example, land use, and building codes.

The community preparedness meteorologists assigned to WSFOs will: identify the weather disaster potential in their areas of responsibility; undertake a broader campaign to educate the public as to how to effectively protect their lives and property against weather disasters; assist the DCPA On-Site Assistance effort in developing community weather disaster preparedness plans and in encouraging the use of drills to keep plans viable; and promote courses on natural disasters in all state and local departments of education.

Disaster surveys have repeatedly shown that communities with good preparedness plans and a well-informed population sustain fewer casualities and often less damage than the unprepared. The assignment of community preparedness specialists to all WSFO to work in conjunction with the DCPA On-Site Assistance effort will bring about the organization of severe storm spotter networks and community preparedness plans in all communities. By temporary mobility assignments, these specialists will alleviate the workload at other NWS stations not manned for coping with hurricanes, winter storms, and flood situations.

Annex I - Roles of Federal Agencies

This section contains a brief description of the role of each agency that participated in preparation of the Plan. The functions discussed are limited to those relating to Natural Disaster Warnings and Preparedness.

Office of Telecommunications Policy

The Office of Telecommunications Policy (OTP) is the Executive agency responsible for overall supervision of national communications matters. It coordinates the planning and evaluates the operation of the communication activities of the executive branch. This includes the establishment of policies and the setting of standards for federal communications systems and overall guidance of federal research and development efforts. It is responsible for administering the nations communications resources in an emergency. This includes responsibilities for exercise of the President's war powers in the communication field.

In November 1971, OTP, with the assistance of NOAA and other agencies, completed a review of policies and programs for the use of telecommunications to provide the public with warning of an enemy attack or of natural disasters. At that time, OTP issued the National policy for the use of telecommunications to warn the general public.

National Oceanic and Atmospheric Administration

The National Oceanic and Atmospheric Administration (NOAA) is responsible for monitoring and issuing forecasts and warnings of meteorological and hydrologic phenomena and conditions that affect the Nation's safety, welfare, and economy; and for detecting, measuring, and reporting seismic phenomena of destructive proportions. To carry out these responsibilities, NOAA has developed and operates extensive systems for the observation, analysis, and forecasting of natural environmental phenomena including hazards and dissemination of forecasts and warnings. In addition, NOAA maintains a complex of laboratories to conduct research and development in order to improve the effectiveness of its various service programs. A major goal of NOAA is to achieve maximum effectiveness of its warning and preparedness programs directed toward mitigation of the effects of natural disasters. The National Oceanic and Atmospheric Administration also has a primary interest in weather modification research as a means to mitigate the impact of severe local storms, extra-tropical cyclones and hurricanes, and to augment precipitation through the modification of tropical cumulus clouds.

Department of Agriculture, U.S. Forest Service

The basic authority for the activities which the Department of Agriculture (Forest Service) carries on in warnings and predictions of extreme fire danger and fire weather, and the warning of avalanche hazard arises from Congressional authorization. This mission includes the responsibility for the security of the market and other values of the land resources, as well as the responsibility for the general safety of persons residing on or utilizing the National Forests. The responsibility of the Forest Service for safety of persons and the security of property on non-Federal and non-public lands within the National Forest boundaries is covered by individual cooperative agreements with States or other governmental or private agencies as appropriate in each case. The disaster related functions of the Forest Service are primarily in fire control and suppression and actions to mitigate the hazards of snow and ice avalanches in parks and public lands.

Department of the Interior

The basic responsibilities of the U.S. Geological Survey (USGS) are the classification of the public lands and examination of the geological structure, mineral resources, and products of the national domain. The USGS makes topographic surveys; geologic and mineral resource surveys; surveys, studies, and research in soil erosion and the preventive measures needed; geological and economic maps illustrating the resources and classification of the lands; and reports on general and economic geology and paleontology. Water resources activities include surveys in arid regions, reservoir sites, gaging of streams for irrigation, publication of reports on stream gaging, water utilization and water supply and the acquisition of lands for use in gaging streams and underground water resources. Floods, droughts, and landslides and related terrain instabilities are included as integral parts of the investigation programs in geology and hydrology. Earthquake and volcanic phenomena are investigated as dynamic manifestations of geologic processes and principles important to the fundamental understanding of the earth and application of this understanding to the solution of practical problems.

The Bureau of Reclamation, as Interior's principal water resources management and development agency, has primary interest in the area of precipitation management, and conducts a comprehensive research program to develop cloud seeding techniques which can be utilized to augment water supplies, particularly in water-short areas of the Nation. Project Skywater, as the program is known, successfully conducted emergency drought seeding projects in Texas, Oklahoma and Arizona during 1971 at the request of the Governors of those states and under the auspices of the Office of Emergency Preparedness.

The Bureau of Land Management has basic responsibilities related to management and protection of certain public lands. With the assistance of the Bureau of U.S. Forest Service, BLM has utilized weather modification technology in an effort to suppress forest fires in Alaska by both augmenting precipitation and by suppressing lightning.

Environmental Protection Agency

The Environmental Protection Agency is not directly involved in natural disaster detection, warning and prediction but does have responsibilities in monitoring and control of pollution in the atmosphere and water resources of our nation. In response to Section 303 of the Clean Air Act, EPA organized the Emergency Operations Control Center to monitor air quality and meteorological conditions throughout the Nation in order to detect air pollution episode situations brought on by stagnant meteorological conditions. EPA's water programs have played a major role in Agency natural disaster activities, although the Agency's participation involves preparation and response rather than prediction and warning activities.

National Science Foundation

The National Science Foundation (NSF) was established to promote the progress of science and to advance the national health, prosperity and welfare. Under the principal provisions of the NSF Act, the Foundation is authorized and directed to initiate and support basic scientific research and programs to strengthen scientific research potential in the mathematical, physical, medical, biological, engineering, social, and other sciences through contracts or other arrangements; to initiate and support scientific research including applied research, at academic and other non-profit institutions and, at the direction of the President, support special applied research at other organizations. The NSF supports a considerable amount of both basic and applied research in the areas of natural disaster.

National Aeronautics and Space Administration

The National Aeronautics and Space Administration (NASA) has broad responsibilities for research and the development of technology for use in space and the maintenance and operation of space flight launch facilities. In support of the National requirements for application satellites, NASA has overall responsibility for research and development of total systems and specific responsibility for definition and development of the space segments of each system.

On January 5, 1973, NASA announced its intention to reduce its overall program. The following excerpts from its News Release No. 73-3 pertain to the Communications Program reductions:

NASA is starting today to make a number of program reductions to adjust its activities in space and aeronautics to a lower spending level. These reductions are necessary as part of all the actions required to reduce total Government spending to the $250 billion target set by the President for Fiscal Year 1973.

NASA has been the catalyst in bringing into being a commercially viable communications satellite business. The technology of communications satellites is being developed further with the flight testing of ATS-F (Applications Technology Satellite) now scheduled for 1974. Further advances in satellite communications research and development can be accomplished by industry on a commercial basis without Government support. NASA will, therefore, phase out of its in-house and contracted communications satellite work, and will cancel ATS-G which is just now getting underway as a follow-on to the ATS-F project.

Department of Defense; Defense Civil Preparedness Agency

The mission of the Defense Civil Preparedness Agency as established by DOD Directives includes "Provide natural disaster preparedness planning assistance to State and local governments in accordance with agreements between the Director, DCPA, acting on behalf of the Secretary of Defense, and the Director, Office of Emergency Preparedness (OEP) and other Government departments and agencies and in consonance with policy guidance provided by the Director, Office of Emergency Preparedness, with specific responsibilities for a program to utilize and make available the civil defense communications system for the purpose of disaster warnings and programs to provide planning assistance to State and local governments in their development of natural disaster preparedness plans and capabilities.

Department of Defense; Corps of Engineers

The Army Corps of Engineers is not directly involved in natural disaster detection, warning, and prediction but does have statutory responsibility and authority for emergency flood control activities including flood emergency preparations, flood-fighting, and rescue work during the period of actual emergency, and post flood repair and restoration of flood control works. Also, the Corps conducts river, lake, and tidal flood plain information studies, and compilation and dissemination of information on floods and flood damages. In accordance with various congressional acts, the Corps also constructs, maintains, and operates projects in the primary interests of flood control and navigation, some of which incorporate hydroelectric power generation. The Corps maintains close coordination and cooperation with other Federal agencies concerned, including many cooperative joint activities.

Department of Transportation

The Department of Transportation has no formal system for forecasting and warning the public on natural disasters. However, through the radar and communications systems of the FAA and USCG the Department has a potential capability. This potential is available and is used as necessary or upon request of local authorities.

The Department of Transportation participates in damage assessment on transportation systems and facilities damage when such occurs. Reports are prepared by field agencies of the Department under the coordination of the DOT Regional Emergency Transportation Coordinators and forwarded by them to the Office of the Secretary.

National Communications System (NCS)

The National Communications System (NCS) is a confederation of Federal Departments and Agencies established by a Presidential Memorandum of 21 August 1963. This memorandum states: "The objective of the NCS will be to provide necessary communications for the Federal Government under all conditions ranging from a normal situation to national emergencies and international crisis including nuclear attack." The Secretary of Defense acts as the Executive Agent of the NCS and has delegated the responsibility of achieving the overall objective to the Manager, NCS. Included in the broad mission of the NCS is the responsibility to support the Office of Emergency Preparedness (OEP) in natural disasters through the application of the communications assets of the NCS Operating Agencies. The NCS is also responsible for planning, at the National level and within each OEP Region, for emergency communications support in natural disasters. Specific support actions are defined in the NCS Plan for Communications Support in Natural Disasters, dated March 1971.

Office of Emergency Preparedness

The Director advises and assists the President in the formulation, development, and coordination of national civil emergency preparedness objectives, plans, and programs. He also represents the President in fostering State and local participation in emergency preparedness programs.

The Director administers the President's Disaster Assistance Program and Disaster Relief Fund and coordinates the assistance efforts of Federal Departments and agencies during major disasters. He also initiates, on behalf of the President, disaster preparedness efforts by the Federal Government.